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SEPTEMBER 1951

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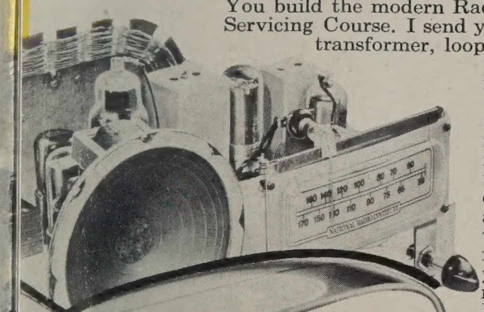
In this issue: **Using TV Test Equipment • Magnetic Amplifiers • Compact Portable Receiver**

J. E. SMITH,
President,
National Radio
Institute,
Wash., D. C.

I Will Show You How to Learn RADIO-TELEVISION

by Practicing at Home in Spare Time

You Practice SERVICING with Equipment I Furnish



You build the modern Radio (at left) as part of my Servicing Course. I send you speaker, tubes, chassis, transformer, loop antenna, everything you need. You use it to make many tests, get practical experience you need to make EXTRA money fixing Radios. I send you many other kits of parts with which you build other circuits common to Radio and Television, some of which are pictured on the next page. All equipment is yours to keep. See and read about them in my FREE 64-PAGE BOOK. Mail card below.

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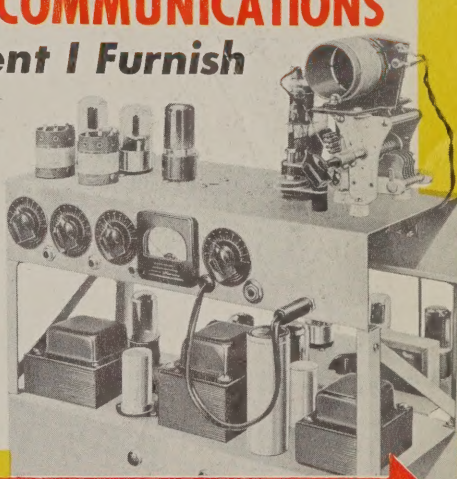

As part of my Communications Course I send you kits of parts to build the low power broadcasting transmitter shown at the right and many other circuits common to Radio and Television. You use this equipment to get practical experience putting a station "on the air," performing procedures demanded of Broadcast Station operators. I train you for your FCC Commercial Operator's License that puts you in line for good pay in Radio or Television Broadcasting. Mail card below.

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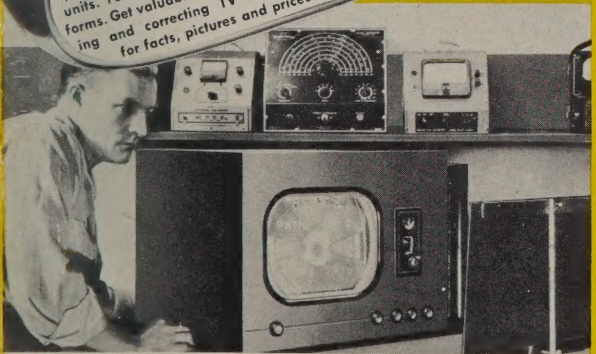

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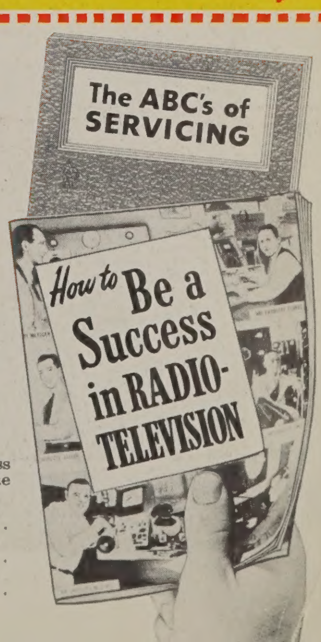

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100.	2.65	100.	2.10	100.	1.90	100.	2.90	100.	3.75	100.	4.10
200.	3.85	200.	3.30	200.	2.85	200.	4.20	200.	5.60	200.	6.20
300.	4.80	300.	4.10	300.	3.60	300.	5.50	300.	7.10	300.	8.00
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ON THE COVER

Radiomarine installation in the radio room of the Esso tanker *Bermuda*, one of the most modern of our merchant marine radio stations. *Ektachrome original by Avery Slack*

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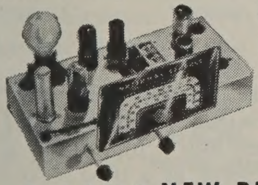

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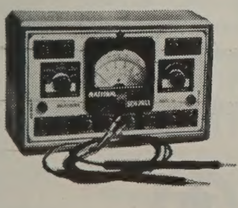

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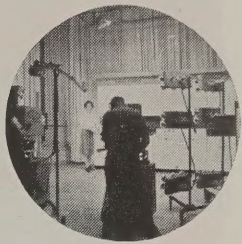

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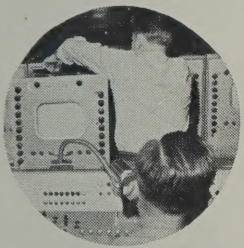

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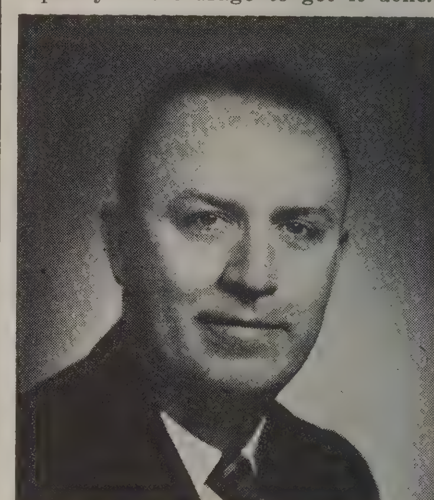
TRANSCONTINENTAL TV is just around the corner. September 30 will see two-channel service initiated on coast-to-coast microwave radio-relay facilities of the Long Lines Department of the American Telephone and Telegraph Co.

Words and pictures will be relayed between 107 towers stretching from New York through Chicago, Omaha, and Denver to San Francisco. The system will handle two channels, one east, one west.

Microwave radio-relay transmissions, coast-to-coast, of telephone calls was scheduled to start August 17. Construction of the project began in 1948. The total cost is 40 million dollars.

LEROY A. WILSON, president of the American Telephone and Telegraph Co., died June 28, in New York City. He was 50 years old, and had headed A. T. & T. since 1948. His formula for success, he once said, hinged on "two simple things—first, the ability of the individual to analyze a situation and decide what should be done, and second, his capacity and courage to get it done."



Mr. Wilson studied engineering at Rose Polytechnic and was graduated in 1922. Starting at $27.50 a week with Indiana Bell Telephone, he advanced to head the corporation which in 1948 had assets totalling more than 10 billion dollars and is the largest corporate enterprise in the world.

A STORAGE SYSTEM using a cathode-ray tube is being introduced by International Business Machines Corp. for use in their new electronic calculators. The system was developed by F. C. Williams, English radar expert and will be used under a licensing agreement with National Research Development Corp. of London.

Information is stored as dots and dashes on the face of the tube in a manner similar to the projection of a picture on the ordinary home TV set.

The information is read back from the tube to the computer in a few millionths of a second by passing the cathode-ray beam over the same area. As many as 2,048 items of information have been stored on a cathode ray tube with a 24-square-inch screen.

Optical comparator is used to check mica disc specifications to thousandth-inch accuracy.

RCA COLOR television tests were started July 9 in New York City. Half-hour programs every morning continued for a week, and another later series was planned. At the beginning of tests, extra programs were transmitted over a closed circuit for press and industry representatives.

RCA's Engstrom holds tricolor tube. He explained processes to other companies.

The morning tests, which included live pickup of outdoor scenes, were received in black-and-white by more than a million receivers in the New York metropolitan area. Stressing the compatibility angle, RCA ran large ads in the metropolitan papers urging the public to monitor the broadcasts and report the results. A huge and enthusiastic response was reported. Many viewers stated that the colorcasts received in black-and-white were better than standard black-and-white television broadcasting.

Reception in color, on special 54-tube receivers, was necessarily confined to a much smaller number. Response was mixed. Some reported that the color pictures seemed hazy as compared to CBS color. Others believed that the texture and detail were better than in Columbia's system.

In line with its policy of putting an electronic color system before the public, RCA is making available samples of the 16-inch basic developmental model tricolor tube and kits of associated circuit components and parts. The photo shows E. W. Engstrom, RCA vice-president in charge of research, holding a cutaway model of the 16-inch tube, with a 21-inch model before him. The occasion was a meeting of 231 radio-TV manufacturers at which RCA explained details of the new tube.

A representative of CBS expressed disappointment because of the complexity of the tube and the problems to be surmounted in manufacturing it. He said he had hoped that the company would be able "to plug it in" to the CBS system, thus eliminating rotating discs and drums. "I thought we would have a nice color tube to shove in, possibly this fall, but its use is pretty far off . . ." He said it would be a long time before production in volume.

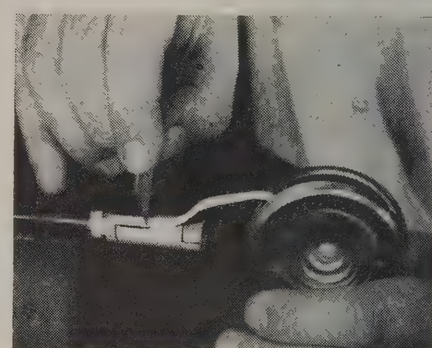
DR. LEE DE FOREST, called the father of radio because of his invention of the three-element vacuum tube, charged in a recent Chicago interview that his "grandchild," television, was running wild.

"Television, which could be so uplifting and enlightening is being used degradingly. In Los Angeles where I live, there are eighty or ninety murders a week broadcast on TV programs, mostly movies . . . It can only have a vicious effect on children . . ."

He said that television had been a disappointment in its handling of good music, and was having an adverse effect on reading of books and magazines. "Sponsors must reform and raise their intellectual levels," he said, adding that they could do so without losing a single viewer.

ADHESIVE TAPE RESISTOR is the latest in printed circuits and miniaturization techniques. A major disadvantage of printed circuits has been the difficulty of putting satisfactory resistors in the circuit.

In this new technique, circuits are printed in narrow metallic bands, leaving a gap at points where resistors are



Resistors are attached and later fired.

used. Resistor lengths are then clipped off plastic tape which has an adhesive backing and which is coated with carbon black or graphite. These resistors are attached at the right point and fired at high temperatures.

The new method was developed as part of a research program sponsored by the Navy Bureau of Aeronautics and devised by B. L. Davis and associates of the National Bureau of Standards. The resistor is manufactured by spraying the resistance mixture onto a moving belt of tape.

RESEARCH by the Advertising Research Bureau, Inc., conducted for WRC-NBC showed that radio produced more traffic and a greater percentage of dollar volume than did equal amounts of newspaper advertising. An important result of the study showed that radio brought in large numbers of customers who had not seen newspaper advertising of certain commodities or services and proves that radio offers a separate market which retail stores thus would have lost.

—end—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Merchandising & Promotion

RCA Tube Dept., Harrison, N. J., has designed an illuminated "Professional Television Service" sign for TV service technicians. Available through distributors, the sign is part of an RCA campaign to promote the sale of its test

equipment and to build prestige for the TV servicing industry. Distribution of the sign will be limited as far as possible to service technicians who own RCA test equipment.

Sprague Products Co., North Adams, Mass., has issued the third edition of its Television Replacement Capacitor Manual which lists capacitor replacements for 964 TV sets under more than 60 brand names.

The manual can be obtained free from Sprague distributors or for 10 cents, to cover the cost of mailing, when ordered directly from the company. Sprague also released a 16-page catalog covering its capacitors, resistors, filters, and other products.

Jensen Industries, Inc., Chicago, has designed a new transparent plastic dealer pack which holds 32 needles. As each needle is removed, information on what to reorder can be seen in the vacant space.

Allen B. Du Mont Laboratories, Inc., Electronic Parts Division, East Paterson, N. J., has issued an instruction brochure for converting small TV sets to larger sizes. The instructions are available to service technicians through Du Mont distributors.

Sarkes Tarzian Inc., Bloomington, Ind., has released a brochure, "UHF Television Reception." The book shows how UHF can be received on any existing TV set with the addition of a Sarkes Tarzian Translator.

Cornell-Dubilier Electric Corp., South Plainfield, N. J., has compiled a manual listing over 400 TV twist-prong electrolytic capacitors. The manual, "C-D's Television Replacement Guide TVR 7," was designed to aid the service technician in selecting the proper replacement capacitor since there are some 500-odd types of twist-prong electrolytics.

The guide may be obtained from distributors or direct from the Jobber Division of Cornell-Dubilier. It is priced at 50 cents.

Hytron Radio & Electronics Co., Salem, Mass., has worked out a new budget plan to help distributors and service technicians sell Hytron TV picture tubes. Under the plan, set owners are able to purchase TV picture tube replacements on a time-payment basis with no down payments necessary. A national finance company is handling the arrangements and the distributor or service technician receives cash in full at the time of the sale.

National Union Radio Corp., Orange, N. J., is offering a tube carrying case free to service technicians through distributors. The company suggests that the distributor offer the case free with the purchase of 500 N.U. receiving tubes made within 60 to 90 days.

Standard Transformer Corp., Chicago, has issued two new catalogs: its mid-year catalog which lists 441 Stancor transformers and related components, and its television catalog and replacement guide listing more than 1,500 models and chassis built under 79 brand names.

The Easy-Up Tower Co., Racine, Wis., has made available a counter piece which displays Easy-Up pole accessories. It consists of a miniature roof on which is mounted a pole section with universal foot mount, fixed pole ring, and two types of rotating pole rings. It is available to distributors without charge.

Astron Corp., East Newark, N. J. manufacturer of capacitors and noise suppressors, is now packaging its products in new, handy, and attractive red-and-black cartons.

The Rauland Corp., Chicago, is offering prize certificates to push TV picture tube replacement sales among service technicians. Jack Powers, jobber sales manager of Rauland, indicated that the prize certificates are worth $1.50 to $4.50 in merchandise for each tube sold. He stated that the program was planned to stress the growing importance of the replacement market as the average age of TV sets increases.

General Electric Co.'s expansion plans include the construction of a 20,000-square-foot building in Springfield, N. J., for Precision Laboratories, Inc., a unit of the company's Components Division, now located in Irvington, N. J. G-E also announced that construction had begun on a new $6,000,000 plant in Anniston, Ala.

—end—

TELEDUCATION

... A radically new type of teaching now becomes possible ...

By HUGO GERNSBACK

"A COUNTRY is only as good as its schools," may be a trite remark. More to the point is the version: "A country is only as good as its school teachers."

By this yardstick the U. S. has been a mediocrity a long time. This appalling situation has steadily worsened during recent years chiefly because teachers as a class are notoriously underpaid and frequently go into other professions or industry where their talents will be paid on a more commensurate plane.

It is within the realm of possibility that television will finally solve this problem that for many years has been a nightmare to forward looking educators.

As early as December, 1945, the writer asked the question: "Why use 100 mediocre teachers when *one* brilliant one can be simultaneously in 100 schools *via* television?"

In recent months television in the classroom has received a great deal of publicity. The usual idea in these projects is merely to have teachers address classes *via* TV broadcast stations. It is not intended to continuously cover all types of classes, but only occasionally. There would still have to be a present day type of teacher in the classroom under such a system. This is a most unsatisfactory means of exploiting television. Indeed, such a system hardly scratches the surface of television's possibilities.

In the future we can foresee an entirely new and revolutionary television development that to the best of our knowledge has not been visualized before. It would work somewhat as follows:

There will be a *TV Education Center* whence issues *all* teaching for *all* the public schools of the city. This would include high schools. The system is, of course, applicable to universities, colleges, or other seats of learning. For want of a better term, let us call the new endeavor *Teleducation.*

Indeed, it is quite possible that in the future there might be a national Teleducation Center which would originate and radiate to the rest of the country the services of the nation's greatest teachers.

Take the City of New York, which at present has over 700 schools and over 35,000 teachers.* It would only require 30, and certainly not more than 50 teachers to teach New York City's 800,000 pupils *via* television. These teachers would be giants in their field—the best that money could secure. Thus, one teacher would teach arithmetic only for the lower grades, another would teach grammar for the higher grades, etc.

With television important physical props in all classes would become eminently feasible. Thus, in the lower grades the teacher speaking from the teleducation center would place a boy behind a row of apples, displayed on a table. Apples would be added or subtracted, using actual apples, while simultaneously the problem and the solution appear on the school's "electronic blackboard". Here figures from 1 to 9 and 0 pop mysteriously into place after meandering all over the board. Colored figures can be used if so desired.

In the geography classes, colored maps can be displayed of any country being studied. These effects and many others are flashed on huge TV classroom screens simultaneously in all the 700 schools.

While standard television equipment can be used, the transmission had best be over wire lines, in order to obtain disturbance-free pictures of the highest quality. All TV broadcasts would be in full color.

In time to come, for greatly enhanced effects, three-dimensional, direct-view stereoscopic pictures will be flashed on the screen.

In the classroom we will no longer have regulation teachers. Instead, there will be a trained "teacher attendant"—a class supervisor—to keep order, to collect all pupils' papers and supervise other activities such as penmanship, individual recitations, etc.

Now comes a rather radical innovation made necessary by class television. During the periods when no teaching programs are being telecast from the teleducation center *the entire class is televised* by special TV cameras in the classroom. Thus the class and its pupils are supervised continuously "by the principal"—actually by a distant electronic gadget which makes a motion picture record on minifilm. This film can be played back by the central teachers at any time in both sight and sound.

Do not imagine that televising the pupils is for eavesdropping purposes. Instead the pupils are encouraged to ask questions, to recite texts, poems, etc. The pupils in turn are asked questions by the teacher attendant, *who however does not grade the pupils.* At the teleducation center special professional educators and grading teachers view and listen to all classes. These educators then grade all pupils. The pupils' most recurring questions are noted by the distant teachers who answer them via television the next day. If required, certain outstanding pupils can be called by name. This the TV teachers can do readily, as all school desks are numbered, these numbers showing in the filming of the classroom.

It would seem certain that television classes will be highly popular with children and students of all ages. "Playing hookey" with the younger element will probably become a lost art! Incidentally, the classroom teacher attendant—most likely a mature woman—will have little to do to keep her occupied when the television classroom screen is "alive". Fighting among the younger children will probably be rare and there will be little censure for unruliness among the smaller fry during the TV teaching period.

It will even be possible for backward children to receive "personal" instruction after school hours, because all programs at the central teleducation center are recorded. It will be a simple matter for the attending class supervisor to request the playing back of certain lessons for the benefit of those children who need extra and repeated instruction.

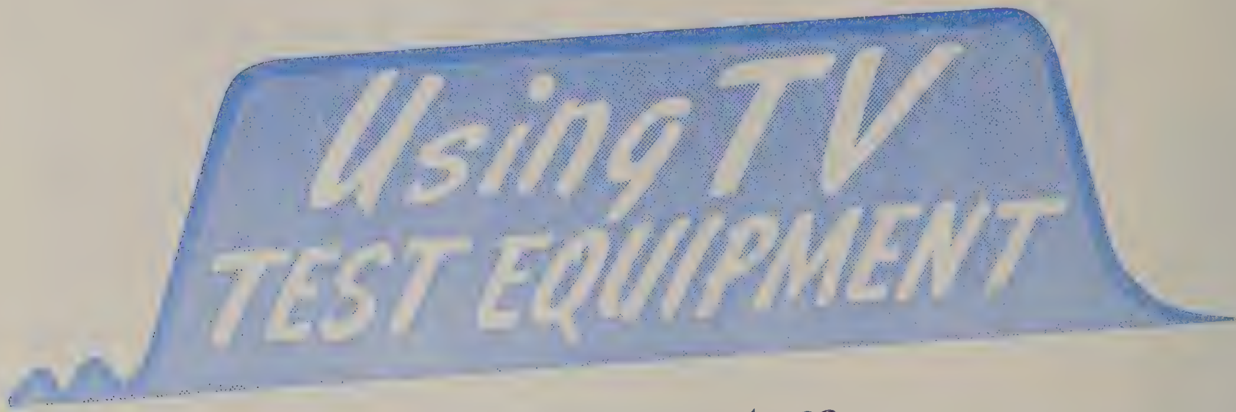
Education via television can become a tremendous force in our future classroom teaching. It is sufficiently flexible to encompass *all* eventualities and in time to come *any* teaching problem can readily be solved by its means.

What will be the advantages of the new teleducation system?

1. Pupils and students will obtain an immensely better education for less money expended.
2. Education will no longer be "spotty" due to incompetent or poor teachers—all grades now having only top flight teachers.
3. "Faulty teaching, due to teacher's quirks, subversion, etc., will no longer be possible.
4. Central supervision of all classrooms by the higher teaching echelon will make for eventual better educational practices.

*New York City at present has five grades of teachers: 1. Kindergarten. 2. 1st to 6th grade. 3. 1st to 8th grade. 4. Junior high school. 5. High school.

(A condensed form of this article was first published on December 10, 1950, in the author's annual Christmas booklet NEWSPEEK.)



Proper procedure and instrument use simplifies TV alignment problems

By H. G. CISIN

THE finest test equipment is worthless if improperly used. It's "what you do with what you've got," that counts. Even mediocre instruments, properly used, can produce worthwhile results. Consider an ordinary television receiver alignment job. This appears to be a routine procedure. You have: the manufacturer's detailed instructions; specified response characteristic curves including marker frequencies; a new sweep-signal generator; a medium-priced scope; and a fairly good multitester with a vacuum-tube voltmeter.

The set seems to need complete re-

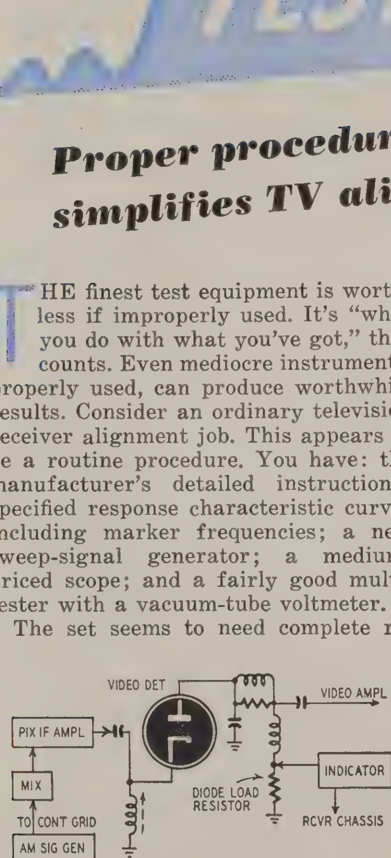


Fig. 1—The traps are aligned first, using apparatus and connections shown.

alignment, so you will proceed as follows: traps including sound take-off; pix i.f. amplifier, including mixer, sound section, oscillator; and r.f. amplifier. The traps are first, since if they were aligned after the pix i.f., the over-all response curve would be spoiled. Align the sound section before proceeding with the front-end alignment, since a correctly adjusted sound system helps in rapid alignment of the oscillator.

Set up the apparatus (Fig. 1) and, following accepted alignment procedure, adjust the traps. If the v.t.v.m. is the indicator, inject an unmodulated signal at the mixer control grid; if the scope is used, inject a modulated signal. Everything seems O.K., so you proceed with the i.f. alignment. The manufacturer's instructions state that this set incorporates an overcoupled pix i.f. amplifier and you decide to use your sweep generator with inbuilt marker for this alignment, using the scope as indicator.

These are connected and here you hit what appears to be the *first* snag. Actually, this is the second, for you neglected to warm up the AM signal generator before using it and failed to *calibrate* it, so the chances are that the traps are more poorly aligned now than when you began. It's a good idea to allow 15 or 20 minutes for the signal generators to become stabilized before starting alignment work. As to calibration, more about that later.

Getting back to the pix i.f. alignment snag, the first response curve obtained from the stage preceding the video detector bears no resemblance to the curve specified by the manufacturer. You manipulate the designated slugs unsuccessfully. You bring down an unwanted peak with one adjustment and it appears incorrectly at another point. You rest your hand on the scope and get a different curve. Worse yet, weird oscillations appear along with the response curve, making it difficult to recognize the real curve.

Causes of alignment troubles

The hand on the scope affects the response curve and is definitely a result of improper grounding. You did ground each instrument to the TV set chassis, using wire, but this is not sufficient. Some of the test equipment was at different ground potentials than others so that stray current flowed between them. Use a copper bench top, with the receiver chassis and all test instruments placed on this. If copper cannot be obtained, galvanized iron will do. Or else bond the units with heavy copper braid, such as electricians use to carry heavy currents.

Use shielded leads for all connections between the instruments and the TV set. Unshielded leads pick up stray currents.

A common cause of misleading response curves is too strong a signal. Use the weakest signal possible. You can use a strong output from the generator when you are first forcing the signal through, especially where the alignment of a single stage is involved and the amplification offered by the stage is small. Just as soon as the desired response is seen on the scope, *reduce* the signal strength at the generator, raising it if necessary at the scope with the scope amplifier. Unless this is done, the response curve will probably be useless. It may show a beautiful flat top as indicated in Fig. 2 but this is due to overloading of the pix i.f. amplifier with resultant "clipping." An overloaded scope amplifier can do the same, so use caution. Always try to work with minimum amplification.

Spurious oscillations

The next step is to get rid of the oscillations which spoil the response curve. Assume you have used shielded leads, but this trouble persists. Oscillations may be picked up from other oscillators in the set. Remove the local oscillator which beats against the incoming signals when the set is in use, unless the manufacturer recommends otherwise. In that case, tune to a high-band channel.

In the pix i.f. alignment of any set where the signal generator connection is moved back stage-by-stage, from the input of the stage nearest the video detector to the input of the mixer, oscillations may come through from the preceding stages. This is true in alignment of an overcoupled i.f. amplifier. To avoid this when the stage nearest the video detector is being aligned, shunt .001-μf capacitors between the control grids and chassis of all the preceding stages. As the signal generator input is moved back to a preceding stage, the .001-μf capacitor at that grid is removed.

It is often possible to shut out unwanted frequency disturbances by con-

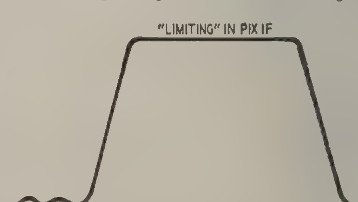


Fig. 2—Clipping due to i.f. overload.

necting a .001-μf capacitor between the vertical and ground post of the scope. This applies only when the scope is connected to the video detector as an indicator, but does not apply to other signals. The video detector is an AM detector, and it detects changes in the amplitude of the signal from the sweep generator. If a signal of constant amplitude (c.w.) is injected, the amplitude varies at the output of the i.f. amplifier as the signal is swept pack and forth across the desired band of i.f. frequencies. This is due to the response of the i.f. amplifier. The sweep takes place at a 60-cycle rate in most sweep-signal generators and the output of the video detectors varies at this rate. Consequently, the .001-μf capacitor across the scope does not affect the response characteristic, but effectually shorts out any high frequencies.

Some technicians also place an isolating resistor of 5,000-15,000 ohms in

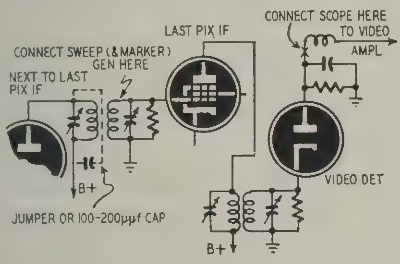


Fig. 3—Keeping overcoupled transformer primary from acting as absorption trap.

series with the V post of the scope, forming an R-C filter. Use this when the scope is connected across a high-impedance point where high-frequency loading effect results from the shunt capacitance of the scope. Although this may be only .00001 μf, the reactance at 25 megacycles is 636 ohms, so the leakage would be considerable. Some of the better oscilloscopes have high-frequency probes which include a high series resistance which forms part of an R-C filter.

Other poor curve causes

Incorrect bias on the i.f. tubes causes trouble in alignment. Verify this by changing the setting of the contrast control (use a TV set whose control changes the i.f. bias) and at the same time watching the response curve obtained in the usual way from a pix i.f. alignment setup. The response curve will change until, when the bias becomes too high, the curve will disappear entirely. Most manufacturers specify the exact bias to be used throughout the pix i.f. alignment process. For example, Magnavox calls for a bias of –3 volts on the i.f. bus line for its CT-219, 220, and 222 models. A better practice is to set the bias at a value which would give normal operating conditions in the customer's home, since a set in a fringe area would normally operate with much less bias than one in a strong-signal area. If the service shop is in the same area as the customer, there should be little difficulty, as the correct bias can be deduced by checking the bias for several stations on a set which is operating perfectly. In other cases, experience can be a guide.

Best procedure always

When aligning an overcoupled i.f. amplifier, the primary of the transformer ahead of the control grid to which the signal is applied will absorb energy in a manner similar to an absorption trap, putting a dip in the response curve. The remedy is to shunt the primary with a jumper or with a small capacitor, approximately .0001 μf, as shown in Fig. 3. When alignment is completed the shunt is removed. This applies to an alignment procedure employing a sweep generator and an oscilloscope.

If an overcoupled system is aligned with an AM signal generator and a v.t.v.m., the primary is shunted with a jumper or a low-value resistor (500 to 1,000 ohms) while the secondary is tuned to a maximum voltage reading. The shunt is then taken off the primary and put across the secondary, while the primary is tuned to a maximum.

Need for calibration

Both the sweep-signal generator and the marker generator must be accurate, otherwise results are valueless. Some commercial generators contain built-in crystal standards. Any well-designed crystal-controlled heterodyne frequency meter, such as the surplus Signal Corps (BC-221) meter, will serve as a calibrator if it covers the necessary frequency range. The zero-beat principle is used. The signal from the generator to be calibrated is beat against a signal from an accurate crystal-controlled oscillator which serves as a standard. Harmonics may be used, thus extending the range of the calibrator.

A commercial unit, the RCA Calibrator, incorporates a 2.5 mc primary and a 0.25 mc, modulating crystal, a heterodyne detector, an audio amplifier and a speaker. The combination of the two crystals will calibrate any signal source over a range of 250 kc to 250 mc. Audible beats are provided to identify the 2.5 mc and 0.25 mc check points. This instrument includes a marker signal generator and is designed to work along with the RCA WR-59B TV sweep generator. It can be used on any other unit, though.

Weakening the marker signal

It is often difficult to attenuate the marker to a point where it will not affect the response. Then a sufficient marker signal may be obtained by connecting the high side of the marker generator to the receiver chassis. Sometimes, even this gives too strong a signal. In this case, try operating the marker generator near the TV set, but without any connection to it. If a marker generator is part of a sweep-signal generator, turn the marker generator "off" except when locating the required frequency position on the response curve. Some technicians put pencil marks directly on the face of the scope to show the location of the desired frequencies, then turn off the marker generator and observe the response curve. Take care not to change the horizontal position of the response curve.

If the signal from the marker generator is too weak and a separate marker generator is used, the signal may be injected into the video i.f. amplifier several stages ahead of a stage being aligned, thus obtaining additional amplification. This applies where the stages nearest the video detector are being aligned. If scope indications are too weak and maximum scope amplification has been reached, the scope may be connected beyond the first video amplifier, or, in fact, at any point in the video amplifier, even to the grid of the cathode ray tube. Use a .1-μf blocking capacitor in series with the lead from the scope to protect against high voltage at the scope terminals. Place the capacitor at the point where the lead connects to the receiver to avoid extra shock hazard near scope posts. To avoid the possibility of contact with high d.c. voltage at the binding posts of the scope, place a 0.1 μf blocking capacitor in series with lead "V" post of the scope at the point of scope connection in the receiver.

Portions of this article are excerpts from the author's forthcoming book "Rapid TV Alignment Method."

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Puzzling Picture Jump

The complaint was that the picture would tear and jump whenever anyone walked across the floor in the same room with the TV console. (Brand new set; using its built-in antenna.) Sure enough! It did it for me when I went to this house on the service call.

I shook the tuner shaft, looking for a noisy tuner—but it wasn't. I removed the back of the set and tapped the tubes gently. Ah, the first video i.f. tube was noisy—the picture tore when it was struck. I replaced the defective tube with a new one and tapped it again. No more tearing.

As I straightened up from behind the set and announced to the owner that I had found the trouble, he stamped his foot on the floor. Result: disastrous! The picture went back to its former tearing. Slightly angry, I struck the cabinet a solid blow with the palm of my hand. Result: very little tearing!

The realization finally sunk in that the trouble must be outside of the set. I circled the room shaking a.c. cords and lamps. When I reached the fireplace, I gave the fire-screen a slight shake. The picture tore with it. I folded the screen, laid it on the floor, and jumped with joy—absolutely no trace of tearing in the picture. The screen had been reflecting the signal from the station into the set's built-in antenna. The owner decided that he would rather watch TV without a fire in the fireplace than move the set to another location in the room.

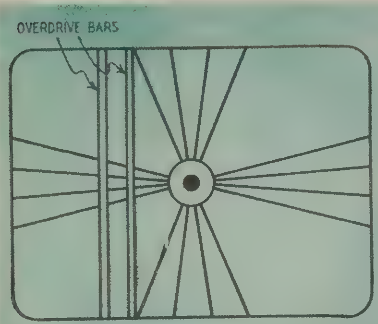


Fig. 1—White bars caused by overdrive.

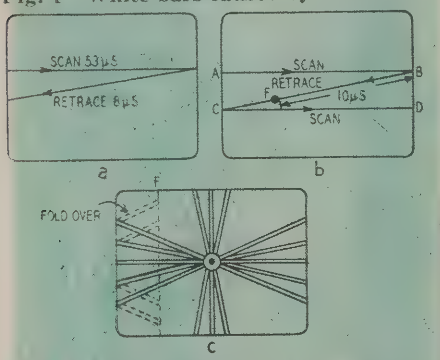


Fig. 2—Retrace times: (a) Good, 8-10 microseconds; (b) Excessive, over 10 µs; (c) Large retrace causes foldover.

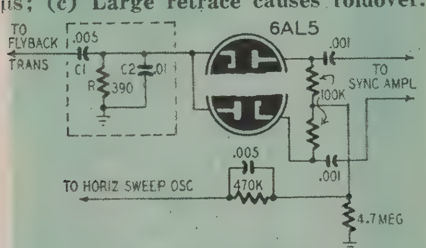


Fig. 3—Horizontal phase-detector.

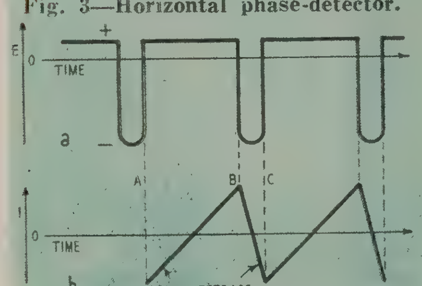


Fig. 4—Yoke voltage, current pulses.

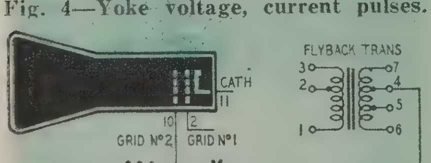


Fig. 5—Screen blanking during retrace.

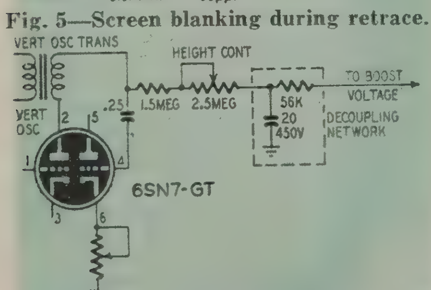


Fig. 6—This circuit gives more height. The decoupling network is essential.

Profitable Conversions with Rectangular Tubes

Part II—Covering horizontal and vertical sweep problems

By TED CANTOR

IN last month's article such topics as focusing, width control, linearity, and power supplies were covered. We now continue with additional considerations of rectangular conversion problems, including horizontal and vertical sweep, and some conversion data for several Philco TV sets.

Horizontal drive circuit

The ouput of the horizontal sweep and high-voltage circuits depend upon the waveshape and amplitude of the sawtooth wave at the grid of the horizontal output tube. The maximum amplitude of this sawtooth is limited by core saturation of the flyback transformer, resulting in the characteristic overdrive white bars as in Fig. 1.

Optimum drive is obtained when the drive control is backed off until the white bars just fade out. If an overdrive condition cannot be produced, then it may be possible to increase the drive as follows: (a) Replace the horizontal discharge tube, 12AU7, with a 12BH7, a 6SN7 with a 6SL7 or 6BL7. No wiring changes are required, but these substitutions cannot be used in series-connected heaters because the heater currents are not identical. (b) Increase the size of the coupling capacitor feeding the grid of the horizontal output tube. (c) Bypass the cathode resistor of the horizontal output tube with a 20-µf, 25-volt electrolytic. (d) Vary the size of the discharge capacitor and resistor in the plate circuit of the horizontal-discharge tube. Decreasing the resistor will usually increase the sawtooth amplitude, so a compromise must be obtained between amplitude and linearity.

Horizontal foldover

Foldover is due to the large distributed capacitance in some yokes and flyback transformers, resulting in increased retrace time. The visible portion of the horizontal trace is approximately 53 microseconds (µs) and the horizontal blanking is approximately 10 µs. If the beam is to be returned to the left side of the picture in time to start the trace and contain all the video information supplied to the kinescope grid, then the retrace time should be no more than 8 µs as in Fig. 2-a. This leaves 2 µs for variations in transmitters, components, and horizontal hold adjustment.

Where the retrace time is from 9 to 10 µs, then foldover may result when the horizontal hold control is varied or different channels are viewed. When the retrace time is over 10 µs, then foldover is *always* present. This occurs because the beam returning to the left side of the screen from *B* to *C* in Fig. 2-b, will have only reached *F* at the end of the 10 µs blanking period. Since video information will be provided immediately to the kinescope grid, part of the picture will be formed from *F* to *C*, and the remainder from *C* to *D*, resulting in a folded-over picture as in Fig. 2-c.

The simplest way to handle this is to shift the phase of the horizontal oscillator to move the foldover off the screen or distribute it equally on both sides of the screen where it may be hidden by the mask. This may be done readily on the RCA syncro-lock type circuit where there is a separate phasing slug.

Many current production sets use a horizontal phase-detector circuit similar to Fig. 3. Variation of R will in most cases act as a phasing control, making it possible to position the foldover where it is least objectionable. Variation of C1 and C2 will have secondary effects. Be sure to reset the horizontal oscillator frequency slug after any phasing adjustment.

Another method—to be tried last—is blanking. The voltage pulses across the horizontal yoke are shown in Fig. 4-a, while simultaneous current through the yoke is shown in Fig. 4-b. The flat positive portion of the voltage pulse occurs from *A* to *B* while the sawtooth current wave through the yoke is sweeping the beam across the screen. When the voltage wave goes negative from *B* to *C*, the current through the yoke reverses, producing the retrace.

Since the negative pulse and the retrace are in phase, the negative pulse can be applied to the number 2 grid of the kinescope, blanking out the screen during the retrace as in Fig. 5. The capacitor sharpens the pulse. The resistor should be 310,000 to 560,000 ohms, 1

watt, the capacitor 40-60 μμf, 600 volts. The number 2 grid is pin 10 on the kinescope tube socket and is connected to 265 to 365 volts, B-plus. Insert the resistor between pin 10 and B-plus. Feed the blanking pulse from pin 4 of the flyback transformer through the capacitor to the number 2 grid. If the blanking pulse darkens too much of the picture, it may be reduced by using a smaller capacitor.

Eliminating arcing or corona

Since most sets being converted were originally designed for voltages of 7-10 kv, take special precautions to avoid corona or arcover. Be sure connections on the high-voltage rectifier socket are rounded and free from sharp points. If the hissing characteristic of corona is heard, it can be easily located in a dark room and the sharp points rounded off.

If arcing occurs from the rectifier socket to ground, insert a sheet of bakelite ⅛ inch to ¼ inch thick, or layers of rubber tape on the chassis directly under the socket to insulate it from ground. If arcing occurs from the cap of the rectifier tube to the top of the high-voltage cage, replace the spring clip on the cap with an Alden or Warren type plastic cap or cut out a section of the cage directly above the cap.

Centering systems

In most conversions, the original centering systems may be used. Additional centering may be obtained by tilting the focus coil or using inexpensive magnetic centering rings which slip over the neck of the tube and are shifted and rotated as required.

Vertical sweep

If adjustment of the vertical linearity and height controls fails to provide sufficient vertical sweep, the following steps will correct this condition:

1. Replace the vertical output tube, a 6K6 with a 6V6, a 6SN7 with a 6SL7 or 6BL7, a 12AU7 with a 12BH7. No wiring changes are necessary, but these substitutions cannot be used in series-connected heaters as the heater currents are not identical.

2. Disconnect the height control from B-plus and connect it to the boost voltage at pin 1 of the flyback transformer. A decoupling network, to keep the vertical and horizontal circuits from mutual interaction is required unless already present as in Fig. 6. Be sure the voltage rating of the original decoupling capacitor is sufficient for the higher voltage (20 μf at 450 volts is a good choice).

3. For additional height, reduce the value of any resistor in series with the B-plus side of the vertical output transformer primary. If necessary connect the primary to the boost voltage through a decoupling network of approximately 10,000 ohms, 2 watts, and 20 μf, 450 volts as in Fig. 7. As this will load down the boost voltage and reduce the high voltage somewhat, use the highest decoupling resistor that provides sufficient vertical sweep.

H.v. and sweep troubles

If there is lack of high voltage—indicated by little or no brightness—bring the end of the h.v. lead close to ground and draw it away quickly. If a large arc is produced, the trouble is probably in the ion trap or picture tube. If not:

1. Try to draw an arc off the h.v. rectifier cap with the tip of a well insulated screwdriver. If a good spark results, the h.v. pulses are reaching the cap of the rectifier tube; the circuit is all right to there.

a. A dental mirror will make it possible to see if the 1B3 filament is glowing. If not, change the 1B3.

b. Check the h.v. filter capacitor for open or leakage. A good one will read infinite resistance. An open one will cause picture bloom when the brightness control is advanced.

c. Check the h.v. filter resistor and the h.v. cable. A defective filter resistor will cause the picture to bloom when the brightness control is advanced.

2. If there is no arc drawn off the h.v. rectifier cap:

a. Check the ¼-ampere fuse in the h.v. B-plus circuit.

b. Change horizontal output tube, damper tube, horizontal sweep generator tube.

3. Check the flyback transformer for resistance and voltage at its terminals. A flyback with only a few turns shorted will usually appear to have normal resistance, but typical indications are: little or no high voltage; excessive cathode current in the horizontal output tube; overheating.

4. An arcing transformer or yoke is indicated by ripples in the picture, hash, flashes, or loss of horizontal synchronization.

5. A shorted yoke is usually indicated by collapse of the sweep or a trapezoidal picture as in Fig. 8.

6. Check for a sawtooth wave at the grid of the horizontal output tube with a scope. There should be at least 60 volts peak-to-peak present. If a sawtooth wave of proper shape and amplitude is not indicated, check through the sweep-generating circuit for open or changed value resistors and for leaky or open capacitors.

Converting Philco sets

The following data is for Philco 1000, 1001, 1278, and similar models. Refer to Fig. 9.

1. Remove original yoke, flyback transformer, and width coil.

2. Remove any resistors shunted from plate to cathode of the damper tube.

3. Replace the h.v. capacitor with one rated for 20 kv.

4. When converting doubler circuits, disconnect one rectifier tube socket and wire up the other for single rectifier operation.

5. Remove the negative side of the 500-μμf h.v. capacitor from ground and run it to the plates of the damper tube.

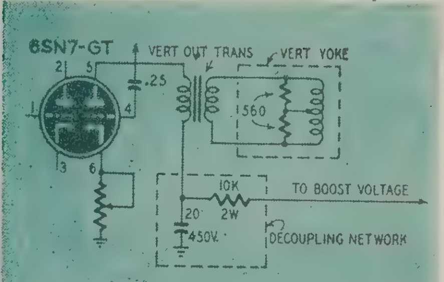


Fig. 7—Another height control circuit. More B-plus is applied in this way.

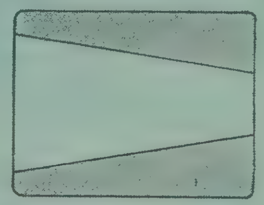


Fig. 8—A partially shorted yoke will cause this trapezoidal type pattern.

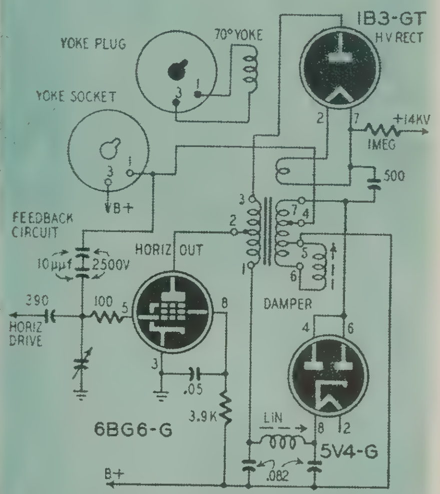


Fig. 9—Philco model 49-1278 modified to use hi-efficiency flyback and 70° yoke.

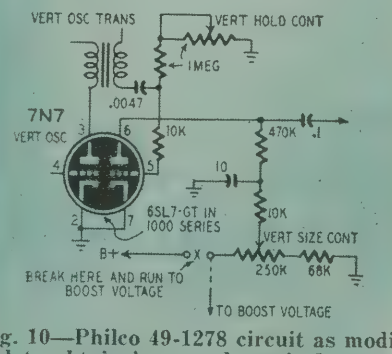


Fig. 10—Philco 49-1278 circuit as modified to obtain increased vertical sweep.

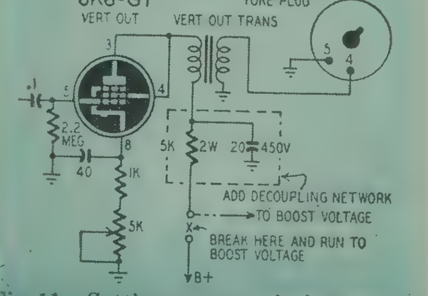


Fig. 11—Getting more vertical sweep another way; decoupling is still necessary.

CONVERSION—a practical approach

Simple changes solve problems in sweep, brightness, deflection

By THOMAS E. FAIRBAIRN

IN converting to 16- or 17-inch picture tubes a 14CP4 should be used first for preliminary adjustments. This tube presents the most problems in sweep, brightness, and degree of deflection. If the 14-inch tube can be swept properly, then any other size can. Experience shows that the 14CP4, 16KP4, and the 17RP4 need the least amount of voltage to produce the greatest brightness, and these are the best tubes to use in conversion work.

First change the old deflection yoke to a 70° unit. After this, the 14-inch tube is placed temporarily in the yoke and focus-coil assembly. A new ion trap is used, and is adjusted so that the picture is brightest. You will note that the picture is not fully swept horizontally. Change the horizontal circuits as follows:

Fig. 1 shows a typical horizontal high-voltage circuit with the necessary changes. The most important part of the conversion is the small 2,000-volt, 160-μμf capacitor, *a*, placed across the plates of the 5V4-G damper tube to ground. In 95% of the conversions, the addition of one or more 160-μμf capacitors will give nearly—or all—the needed sweep.

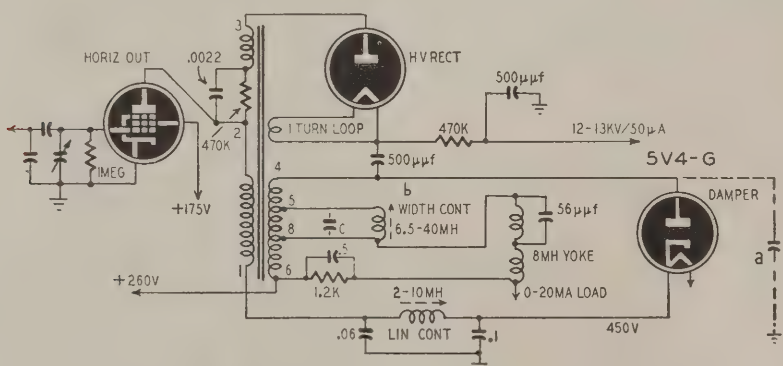


Fig. 1—Typical horizontal output circuit with conversion changes discussed.

If there is a width coil, *b*, in the circuit, Fig. 1, remove and replace with a .05-μf, 600-volt moulded capacitor, *c*, Fig. 1. Do not remove the width coil from sets that have a double coil width control, as part of the coil is used to feed back voltage for the a.g.c. system and with it open you will lose control of the horizontal hold.

Reduce the cathode resistance in the vertical amplifier by one-half if there is not enough height. If this is not enough, replace the vertical amplifier 6K6-G or -GT with a 6V6 or 6V6-GT, or the 6SN7-GT with a 12BH7 with an adapter plug.

Replace the 14-inch tube with the 16KP4 or 17RP4. A marked picture improvement should be noticed. If after having adjusted the horizontal drive control the width is still not enough, use additional 160-μμf capacitors across the damper tube. If there is still low brightness, replace the low-voltage rectifier with a 5U4-G. If still low, for the needed picture width, replace the flyback transformer with the latest high-efficiency type.

Focus is checked next. If the tube does not go through focus properly, cut

PROFITABLE CONVERSIONS WITH RECTANGULAR TUBES

(*Continued from preceding page*)

Refer to section on h.v. capacitors in Part I, in the August issue.

6. Fasten the XO35, or equivalent, transformer to the side of the high-voltage cage.

7. Solder filament leads to pins 2 and 7 of the 1B3 socket.

8. Connect the leads of the wide angle ferrite yoke to the yoke plug.

9. Disconnect the high side of the horizontal yoke from the plates of the damper tube and run it to pin 4 of the flyback transformer. If there is a blocking capacitor in series with the lead, it may be left in place. The capacitor keeps d.c. out of the yoke to facilitate centering.

10. Connect the plates of the damper tube to pin 7 of the flyback transformer.

11. Connect pin 5 of the flyback transformer to B-plus.

12. Connect a 201R4 width coil between pins 5 and 6 of the flyback transformer.

13. Connect pin 1 of the flyback transformer to the linearity coil.

14. Connect two 10-μμf, 2500-volt capacitors in series from pin 4 of the flyback transformer to the grid of the 6BG6-G providing feedback for additional sweep and high voltage. Refer to Fig 7 in Part I, August issue.

Vertical sweep circuit

To increase vertical sweep:

1. Substitute a 6V6 for the 6K6 vertical output tube (Fig. II).

2. Disconnect the vertical size control from the B-plus and connect it to the boost voltage at pin 1 of the flyback transformer as in Fig. 10.

3. If this additional voltage fails to provide sufficient vertical sweep, then connect the B-plus side of the primary of the vertical output transformer to the boost voltage as shown, Fig. 11.

Focusing circuit

If the focus control does not have the required range, then insert a 100- to 500-ohm, 5-watt resistor in series with the focus control to reduce its shunting effect and pass more current through the focus coil. Refer to the previous section on focusing in Part I, August issue.

—end—

out the shunt resistor across the focus coil. This allows more current to flow through the coil. The same result can be achieved by increasing the size of the resistor—because with a larger resistor, less current will flow through it and so a larger fraction of the total current will go through the focus coil.

The service technician should now go through the chassis and feel if there are any resistors which are getting too hot from overload. Replace these with higher-wattage units.

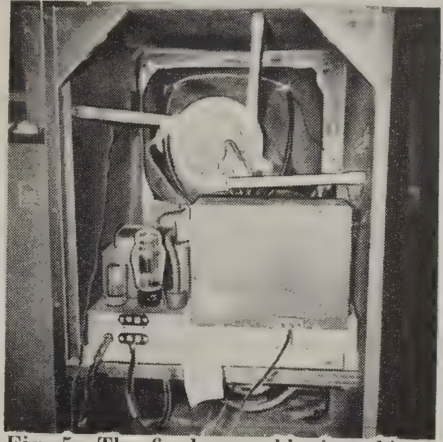


Fig. 5—The final assembly in cabinet.

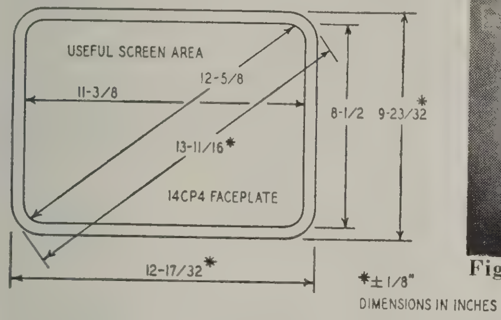
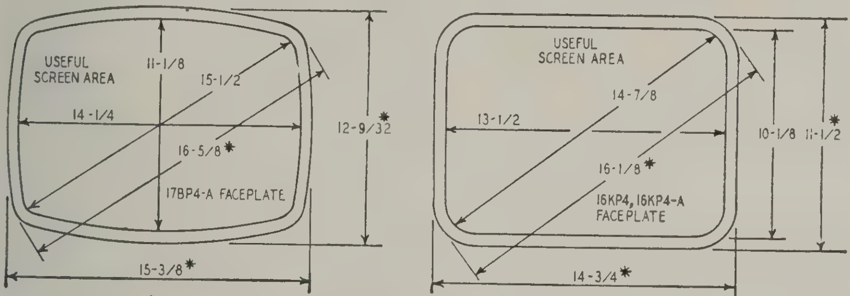



Fig. 2—Dimensions of three popular TV picture tubes.

Fig. 3—Cut-out before installing mask.

Fig. 4—Tube (14 inch) mounted on chassis. Larger ones go in cabinet.

Carefully examine *all* the set components as a matter of routine procedure. Suspicious parts should be replaced. This is especially true of parts subjected to heat, high current, etc. Check the tubes before starting conversion. Sometimes just replacing a tube or two will simplify your conversion problems.

Chassis conversion is now complete and the picture tube is fitted in the cabinet. Fig. 2 gives useful measurements of the 14CP4, 16KP4, 16KP4-A, and 17BP4-A. Fig. 3 shows the cutout before the mask is installed (always cut the hole smaller than the mask).

Fig. 4 shows the tube mounted on the chassis. Most of the 14-inch conversions will mount on the chassis, and the majority of the 16- and 17-inch conversions will mount in the cabinet as a rule (Fig. 5).

In some conversions it is necessary to lower the wood bottom to make room for the larger tube. The chassis may have to be relocated. The leads of the focus and deflection coils, the high-voltage and picture-tube socket will probably have to be lengthened.

Final adjustments are made after the chassis is installed. The deflection yoke is adjusted and tightened. The ion trap is set for maximum brightness. Sometimes there is still a slight shadow in the picture. Proper adjustment of the ion trap may remove this.

In a future issue additional problems in large-screen conversion will be discussed.

—end—

September TV DX

If we think of TV only in terms of sporadic-E skip, bringing in signals from distances of 600 to 1,500 miles or more, September will be a barren month. On the other hand, the bright hot days and cool nights that characterize September in many parts of the country are ideally suited to dx reception of a less spectacular but no less interesting sort: the extension of normal receiving range by wave bending in the lower atmosphere.

Because this phenomenon is directly related to observable weather conditions it may be predicted on a short-range basis with considerable success. Tropospheric bending is generally best in periods of fair calm weather, or gradually increasing cloudiness. Watch the daily weather maps printed in many newspapers. When a large slow-moving high-pressure area moves across your locality, fringe-area reception is sure to be better than normal. If the path between you and a TV station is across a pronounced "low," or if there is heavy rain or high winds, reception is likely to be poor and erratic.

Tropospheric dx reception is much more a test of the quality of the TV receiver and antenna installation than is the sporadic-E skip dx of the early summer months. Like dx signals on the short-wave bands, sporadic-E dx comes in via reflection from the ionosphere, often at a fairly high angle. If the ionization is dense and steady the signals are reflected with almost no loss. The result is that the energy received from stations 1,000 miles or more away may be about equal to that of a local.

Tropospheric reception, on the other hand, is often a matter of a relatively small increase in the field strength of a station that is not well received under average conditions. If you are 100 miles from your TV station, for instance, you can expect many nights of good picture quality during September. If you are a dx enthusiast and willing to go to some trouble in erecting a big antenna system or building a good low-noise preamplifier, September will be one of your most rewarding months.

Particularly on the high channels does this sort of thing pay off. The average TV installation is poor on channels 7 through 13. Pentode front ends work well enough on the low channels, but tend to be ineffective on channel 7 and up. Neutralized-triode or grounded-grid preamplifier stages and properly designed *large* antenna systems could work wonders in improving high-band reception. September will provide opportunities for high-band tropospheric dx up to several hundred miles, but only in certain areas.

Literally hundreds of observers have sent in dx reports during the summer, in such volume that it is no longer possible to acknowledge them individually in these pages. The reports are being studied, however, and the co-operation they represent is deeply appreciated.

—end—

Vari-Directional Antenna is "Rotated" By Switching

Many advantages of directivity obtained without a drive motor

By MATT MANDL and ED NOLL

A NEWLY marketed antenna called the *Directronic** permits changing beam directivity without physical rotation of the elements. Thus it can be oriented for virtually every direction by a simple switching unit at the receiver.

Most installation men who work in areas where stations from several di-

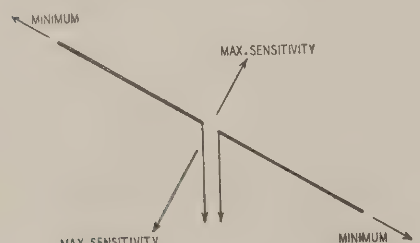


Fig. 1—Signal pickup of simple dipole.

rections are encountered know what a trying and time-consuming problem it is to get best antenna orientation. It is equally difficult to establish optimum signal-to-interference figures on all channels (particularly with an assortment of low- and high-band stations to contend with) when the location is a noisy one. The additional v.h.f. and u.h.f. assignments proposed by the FCC can only make these problems more acute. Obviously, a simple controlled-pattern antenna is a direct and inexpensive solution.

The principles underlying this beam-selector antenna can be best understood by reviewing some basic antenna func-

* Snyder Mfg. Co., Philadelphia, Pa.

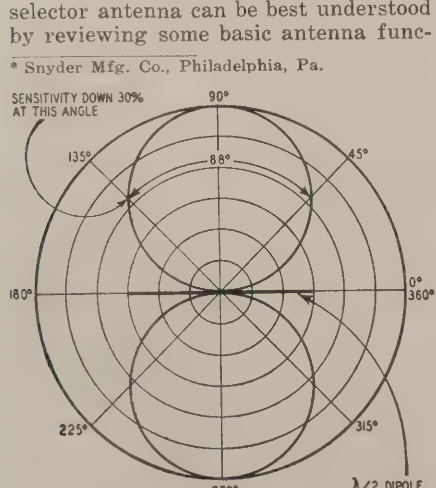


Fig. 2—A dipole's sensitivity pattern.

tions. Peak sensitivity of the standard half-wave dipole, for instance, is broadside to its elements as shown in Fig. 1. As seen from above, such an antenna has a pickup pattern in the form of a figure eight. The acceptance angle (Fig. 2) of such a half-wave antenna (the angle between voltage levels at which antenna sensitivity is down 30%) is some *88 degrees* (44 degrees to either side of best-signal position). Thus, there can be an appreciable error in orientation without serious loss in signal level. In fact, an orientation error of plus or minus 30 degrees would result in only a 15% decline in sensitivity (–1.3 db). Such a slight loss goes unnoticed on the modern receiver (particularly with a.g.c. circuits in operation).

Therefore, one possible method for receiving signals from any bearing *through 360 degrees* would be to mount three separate dipoles on a mast, run three separate lines, and make a switch mount at the receiver so any one line could be selected. The three separate dipoles would be mounted 120 degrees apart, producing a lobe maximum each 60 degrees (six lobes). At only one point between maxima would sensitivity be down as much as 15% (Fig. 3). Desirable orientation advantages are secured, but the system has three separate lead-ins to contend with, besides being costly and inconvenient.

How can we secure the benefits from such a system with a relatively simple installation? Mounting just *three quarter-wave* elements 120 degrees apart in the same horizontal plane as shown in Fig. 4 will do the trick. A *single 3-wire* line connects these three elements to a switch at the receiver. The switch selects any two of these antenna elements to form a half-wave antenna with a specific orientation.

As indicated in Fig 5-a, the switch shifts the element connections and thereby brings about a 20-degree shift in the figure-eight lobes, permitting a maximum choice for each 60 degrees identical to patterns of Fig. 3. Because of the switch arrangement, lobe switching is, of course, instantaneous.

With a 120-degree mounting relation between quarter-wave elements, there is a definite forward tilt to the quarter-wave elements chosen to form a given half-wave antenna. This tilt does no harm to low-band performance and has the added advantage of improving reception for higher channels. This is so because the forward tilt of elements cut for a low band will align and combine the high-band lobes so they have maximum pickup characteristics in the same direction as the low-band figure-eight pattern. Inasmuch as the lobes in the direction of the forward tilt combine, they serve to give the antenna unidirectional characteristics on the high channels with added gain.

A typical commercial antenna of this type would be cut for channel 3, producing an 88-degree figure-eight pattern. This antenna would perform up through channel 6 with only slight change in acceptance angle. On the high-band channels the lobes tend to narrow, but the forward tilt of the elements increases gain. This means that in most metropolitan and near-fringe areas *no orientation* of the antenna is necessary during installation, inasmuch as orientation of pattern is controlled by the switch at the receiver. However, in a critical location for a particular high-band station, some slight initial orientation would be of some help in obtaining maximum results.

Such an antenna lends itself easily to stacking, as shown in Fig. 5-b. This makes for a higher-gain construction in fringe areas and reduces pickup from above and below. Added advantages of decreased ignition or airplane interference are realized. In field tests, excellent results have been procured in excess of 60 miles.

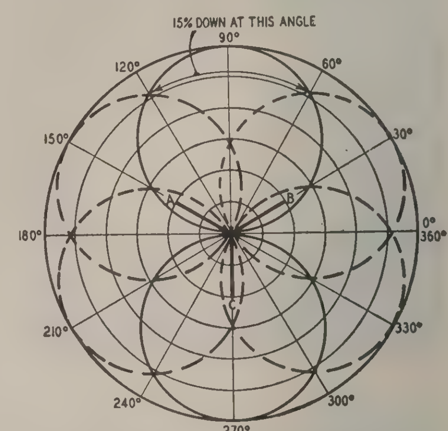
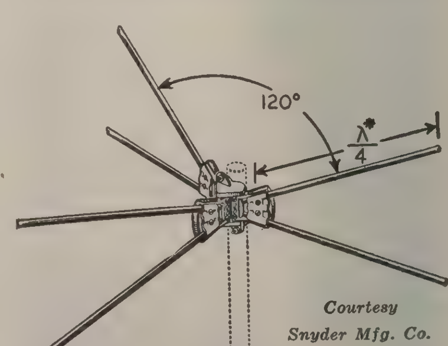


Fig. 3—Pickup pattern, three dipoles.



*LESS 5% FOR END EFFECT

Fig. 4—How a Directronic antenna looks.

Problems that can be solved

There are numerous applications for such a lobe-switching antenna system. In metropolitan and near-fringe areas it solves orientation and interference problems. As shown in Fig. 6, it permits optimum orientation for each channel. For example, elements A and C would be used to pick up channel 6, elements A and B for channel 3, while B and C are used for channel 10. This is one way of minimizing the influence of noise, for it makes signals as strong as possible for each station without a compromise in antenna orientation.

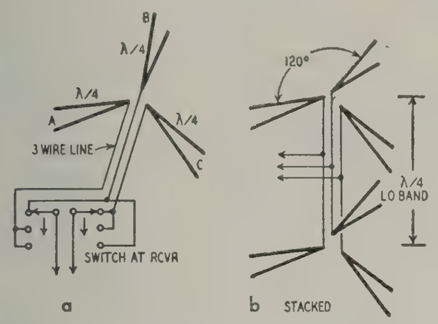


Fig. 5—Switching and stacking methods.

It should also be mentioned that in a strong signal area, good results can be obtained on at least two positions of the switch due to overlap of lobes. Thus, a switch position can be chosen that has the least interference pickup. For example, in Fig. 7 the elements A and B normally would be switched to receive station S. However, a strong noise level is being picked up from point N. If elements A and C are switched in, signal from S is reduced but would still be reasonably strong (down 35%), while the noise component would be *down as much as 80%*. Thus, in the presence of noise, choose a switch position which permits best signal-to-noise ratio. In fact, for a critical noise condition, the antenna can be oriented slightly on the roof to a position that has the least noise pickup for a given switch position. The antenna can thus be helpful in minimizing local oscillator interference as well as ghosts and other types of interference. The reasons for this are twofold: it can be beamed directly on each station or switched to the position of least noise pickup.

Fringe-area tests have indicated good performance for this antenna type (stacked). In a weak-signal area, some improvement is secured for a weak high-band station if the antenna is oriented slightly as the station is being received on the best switch position.

Note that if stations are all in the same direction this antenna has no particular advantages (any more than a motor-driven job). It is basically a problem antenna and gives peak performance when stations are in different directions or in areas where directional noise and interference prevail.

Switch and transmission line

The switch must be of low-loss, low-capacity construction to minimize losses, particularly on the higher channels. It can be mounted at the rear of (or alongside) the receiver. Such a simple switching arrangement can become a part of a manufactured receiver or tuner. It would also be convenient if such a switch were incorporated in manufactured boosters.

The transmission line *must* have good-quality dielectric. It cannot be a high-loss 3-wire motor cable! A poor line can destroy most of the advantages of this lobe-switching system, for it destroys signal levels. The line should be 300 ohms between outer conductors. With such a value the impedance drops to approximately 200 ohms between center and either outer conductor of the 3-wire line. There is only a minor loss of a fraction of a db per hundred feet with this small mismatch to a 300-ohm antenna. Losses due to line capacitance, poor dielectric, and weather attenuation are far higher. Therefore the slight mismatch is relatively minor compared to losses which are experienced with poor installations or poor lead-in.

Fig. 6—Typical reception in large city.

Installation factors

With the flat, 3-wire line, lead-in installation is identical to that employed for the conventional 2-wire line. Standoff insulators should be used to keep the transmission line well away from metal objects or guy wires to prevent losses. This is of particular importance on the high channels, for the capacitance effect increases due to the lower ohmic shunting path encountered. This, of course, holds true for any antenna installation where the twin-lead type of line is used, and such precautions should not be ignored with the lobe-switching type. Again, as with conventional antenna installations, the lead-in should be given a 180-degree turn every foot or so. This twisting of the transmission line will decrease noise interference picked up by the transmission line some 30%.

The switch is of a wafer type, and must be capable of selecting *any two* wires of the 3-wire line. The 3-wire line from the antenna terminates at the switch, and another conventional 2-wire twin-lead section connects the switch to the receiver input terminals. For receivers with 75-ohm input, a coaxial cable section can be used from the switch to the receiver terminals.

In areas where signals are relatively strong, little difference in contrast may be noticed in either of two switch positions. This is due to the automatic gain-control action of modern receivers. It will be noted, however, that in one position picture quality is better because of better orientation. Slight snow effect also will be overcome under such circumstances.

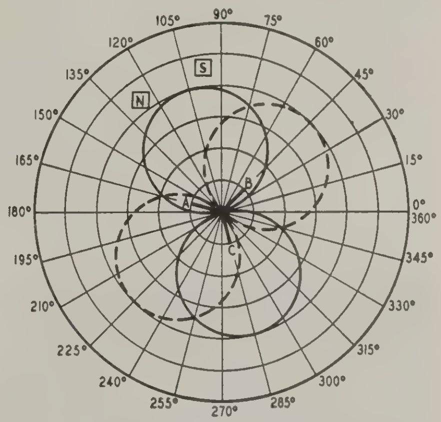


Fig. 7—Switching to reject interference.

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ION BURNS ARE AVOIDABLE

Ion burns on picture tubes can be prevented. Here are some fundamental facts. We know that the ion is an atom with electrons added or removed. If there are fewer negative charges (electrons) than there are positive charges in an atom, the atom is positive-charged and is a "cation." If there are more negative than positive charges, the atom is an "anion."

Ions are always present in cathode-ray tubes. Some "anions" come into the electron beam from the cathode. If they are not diverted—or trapped—they are accelerated to the face of the tube and a phosphor burn may result. Compared to the electrons which normally make up the beam, these "anions" are like A-bombs hitting the anode and screen. They range in size up to 100,000 times the size of the electron.

In electrostatically deflected tubes, ions are deflected equally all over the tube and there is no burn. But in magnetically deflected tubes, because of the field of the yoke, most ions strike approximately the same spot on the screen—and burn.

Remember these five points:

1. Adjust the trap for maximum brightness with the brightness control set halfway.
2. Use the trap recommended by the manufacturer.
3. When using a double-magnet ion trap set the stronger magnet at the rear (next to the base of the tube).
5. Be sure that there is enough spring in the ion trap so that vibration or jarring does not shift it.

—end—

Television Service Clinic

Conducted by MATTHEW MANDL

WHEN we answer queries submitted, our diagnosis of the trouble must be based on symptoms the reader lists. It is essential, therefore, that we get a complete description and explanation of the trouble, whether it exists on all stations and corrections attempted prior to writing. The name of the receiver, model number, and tube complement are also important. All this information is necessary to evaluate the trouble and suggest remedies.

A particular symptom, by itself, is often meaningless; it could be caused by any one of a number of circuit faults. Fig. 1-a, for instance, shows a negative picture, but does this type of picture occur only for the strongest station? If so, it would indicate overload or an improperly set a.g.c. system. Does the picture turn negative only occasionally? If so it might indicate strong local interference from short-wave station. Is the picture always negative, though the antenna lead in is disconnected and receiver circuits check all right? The picture tube is probably defective. Obviously, a correct diagnosis of the trouble can be made only if *all* symptoms are considered.

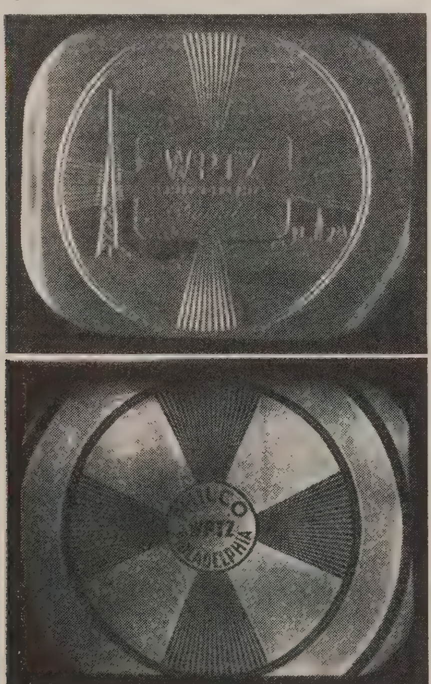


Fig. 1—Puzzling pictures can have many causes. (a) negative; (b) much too dark. Correct diagnosis requires care.

Another example is Fig. 1-b, where the picture is excessively dark, but not fuzzy or negative. Does the brilliancy control still function to increase and decrease brightness? If so, the trouble may be a defective contrast control. Can the contrast be varied though the picture still remains dull? Perhaps the fault is in the brilliancy control or its associated resistor network. Is an r.f. type of high-voltage power supply used in this receiver? The oscillator trimmer capacitor across the tank circuit of the high-voltage system probably requires adjustment.

The same need for facts holds true for defects in sound, in sync stability, linearity troubles and picture interference. Give us the complete story. Help us to help you. The questions which appear in this column are brief because they have been condensed to meet space requirements.

Intermittent brightness

I have an RCA 2T51 receiver in which the brightness is intermittent. When the brightness increases I lose vertical and horizontal sync. Advancing the contrast control will restore synchronization, but with the increased brightness there is also an increase in vertical height. H. S., Bayonne, N. J.

Your trouble is due to either a bad tube in the sweep system, or a defective part between the horizontal sweep oscillator and the input to the 6AU5-GT horizontal output tube. The defective part increases horizontal drive, which in turn increases high voltage and thus the brilliancy. The increased drive and high voltage also increases the output from the voltage boost system. Inasmuch as the voltage-boost system feeds both the horizontal sweep oscillator plate potential as well as the B-plus for the vertical sweep oscillator, the change is sufficient to upset both vertical and horizontal synchronization.

By advancing the contrast control, sync is re-established because this increases the amplitude of the sync pulses sufficiently to lock in the sweep oscillators again. (Sync pulses are taken at the d.c. restorer circuit *following* the contrast control.) The increased voltage boost also feeds the vertical-sweep output tube plate via the primary of the vertical output transformer, and the increased voltage here increases height.

Try a new 6SN7-GT horizontal oscillator, as well as a new 6AU5-GT horizontal output tube. If this does not help, check all components for correct value (between the plate of the horizontal oscillator and the grid of the horizontal output tube). Keep a v.t.v.m. across one voltage source at a time to see if this changes when brightness advances.

Spots on screen

What causes brownish spots on the screen of a 16RP4 picture tube? This condition developed over a period of time and adjustment of the single-magnet ion trap does not help. I intend replacing this tube with a new 16RP4 and want to avoid this condition. H. B., New York, N. Y.

A 16RP4 requires a double-magnet ion trap. This is probably the cause of your trouble. Brownish spots are also caused by an incorrectly adjusted ion trap. New tubes can be permanently damaged if the ion trap is not adjusted properly as soon as the set is put into operation. With wrong trap adjustment the electron beam strikes the disc aperture of the gun structure and may decompose the metal. This vaporized material will cause brownish spots on the tube face which cannot be eliminated. On new tubes keep brilliancy down and advance it slowly as the ion trap is adjusted in a rotary, forward and back motion. Only when correctly adjusted should the brilliancy be advanced substantially.

Vertical transformer replacement

I replaced a defective vertical output transformer on a Raytheon model M1105 receiver and since then have had considerable trouble with a buzz from the speaker. The buzz increases with an advance of either the volume control or when the fine tuning control is adjusted for best picture. F. S., San Diego, Cal.

If nothing else was disturbed when you replaced the vertical output transformer, the buzz you describe may be due to the fields of the transformer affecting the audio circuit with the 60-cycle vertical repetition rate. This interaction between the two circuits would account for the fact that the buzz increases with an advance of volume control or adjustment of fine tuning.

Tighten all bolts to make sure the transformer has a good electrical connection to the chassis. Extra shielding also may help if the new transformer is developing stronger fields. Repositioning it with respect to other circuits also will help.

Your trouble may be due also to a disturbance of some other circuit which has increased in carrier buzz, for the same symptoms would result. Check both video i.f. and sound i.f. alignment.

Unstable vertical sync

In a Regal Model 16T31 (similar to RCA 630) there is bad vertical sync stability which requires fairly frequent adjustment of the hold control. New tubes in the separator and oscillator circuits did not help. S. S., Mattapan, Mass.

The vertical hold trouble you are having is most likely caused by a change in value in one of the parts in the grid circuit of the vertical blocking oscillator.

Take a resistance reading of grid leak and hold-control potentiometer and if they are off value by more than 10% replace them. If this doesn't help, try a new grid capacitor. Check for incorrect parts values in the integrator circuit. You should also check voltages at the plate of the second sync amplifier and the negative potential at the bottom of the integrator network, Fig. 2. Misalignment resulting in poor low-frequency response is another cause of poor vertical stability.

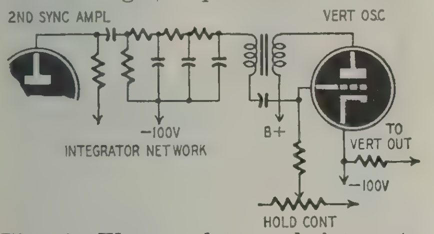


Fig. 2—Wrong plate and integrator voltages may cause unstable vertical sync.

Yagi antenna

One of my customers is moving to an outlying location near Tampa, Florida. The nearest television station is in Jacksonville, about 190 miles distant by road. He tells me the land around Tampa is very level and slightly rolling south of Jacksonville.

I am recommending a double-stacked Yagi because the single station (channel 4) is the only one he will be able to receive. Would you also suggest a good two-stage booster and changing the i.f. tubes in his Admiral receiver? Would an antenna height of 60 feet be adequate? E. W., Buffalo, N. Y.

Your idea to use a stacked Yagi for the channel 4 station is a good choice. This is the logical antenna to use for only a single station because it will give much higher gain than virtually all others for use in the present allocations. A good two-stage booster will be of decided help, though we would not suggest changing i.f. tubes or "doctoring" alignment unless absolutely necessary. Try to get a good grade of twin lead, or use open-wire line, for the latter has less loss than the other types. A height of 60 feet is good, but usually the higher the antenna the better.

Loss of width

A 16-inch RCA TC166 developed loss in width after eight months of operation. There is now a one-inch space on each side and adjust of controls doesn't help. Replacement of the 6BG6-G, the 6W4 damper, the 1B3 and the 6SN7 oscillator increased the width slightly, but it still does not fill out the mask. Brightness and contrast are excellent as well as focus and vertical masking. J. M., Lynbrook, N. J.

First try replacing the 5U4-G rectifier, which you have not mentioned. If this does no good the decrease in width is probably due to degeneration in the horizontal output circuit which is decreasing deflection below normal. Since you have tried tube replacement, check for proper voltages at the screen of the 6BG6-G (*not plate*) and from grid to cathode. Also check the values of grid leak, screen-dropping resistor, etc., and replace if they are off by more than 10%. Also check by direct replacement the several capacitors associated with this circuit, for any defective one may cause degeneration. Use an oscilloscope and check for proper peak-to-peak voltage of driving signal at the grid of the 6BG6-G tube.

Poor brightness

A Sylvania T1-125 developed poor brightness. Contrast and definition remained good, but the brightness control must be at maximum to get fair briliancy. I took a reading from pin 2 of the picture tube to chassis and got 15 to 60 volts, depending on the setting of the brilliancy control. Voltage feed to the control is 125 volts. While taking this reading I got more brightness than needed with voltmeter (not a v.t.v.m.) attached. What causes this condition? F. S., Freemansburg, Pa.

With a negative voltage of 125 present at the brilliancy control, you should be able to get a variation at pin 2 of the picture tube from 40 to approximately 115 volts instead of only to 60. The amount you got, however, may be partially due to the loading effect of your voltmeter combined with a defective resistor in this circuit. The fact that brightness increased with the application of the voltmeter indicates that the resistance of the voltmeter has compensated for a defective (excessive resistance) condition between pin 2 and chassis.

Check all three resistors associated with the brilliancy control and grid circuit for change in value or open circuit. Replace any which are off rated value by more than 10%. Inasmuch as the 6AQ5 video amplifier in this receiver is directly coupled to the cathode of the picture tube, resistor values are critical if a proper range of bias is to be maintained.

Intermittent sound

Picture is all right, but the sound fades down to a whisper. When I turn up the volume control, the sound is good for a while, then suddenly blasts in and I have to cut down on the volume. What is the best method for locating this trouble? J. W., Pittsburgh, Pa.

Intermittent troubles have always plagued the servicing technicians, and they are sometimes the most difficult things to localize. While the set is playing normally, there is no point checking voltages or parts, since nothing appears amiss. However, when the intermittent occurs, it may be of such critical nature that the mere approach of a test instrument probe is enough to cause the part to act normal again.

I suggest you try replacing one tube at a time and waiting to see if the trouble still occurs. Repeat, until all tubes in the audio section (i.f. amplifier to audio output) have been replaced. Also, install a new coupling capacitor in the grid of the audio output tube, for these are frequent offenders. As a last resort gently push each paper capacitor with an insulated screwdriver while the set is in operation in order to find which might have loose internal lead contacts.

There are other methods for checking intermittents. Try raising the line voltage or applying shock. In using higher voltages, a variac or similar autotransformer will be useful. Raise the voltage to about 130, maximum, but don't keep it there too long, and look out for sudden failures.

Open grid resistors, faulty filters, trouble in the output transformer, voice coil, and proper seating in tube sockets (if miniature tubes are used) are other sources to check.

The automatic signal tracers, such as the *Chanalyst*, which can be hooked into several parts of a circuit, and show by the indication on an electron-ray tube the part of the circuit in which the intermittent occurs, are very useful in locating this type of fault.

Picture drift

In a receiver using a Sarkes Tarzian tuner, the oscillator drifts quite a bit on channel 13, and as the picture fades out, noise levels increase and snow effect becomes very bad. I have tried a new local oscillator tube without effect. There is a slight drift on the lower channels, but it doesn't affect performance nearly as much as it does on channel 13. I have also changed the tuner, but the results are the same. H. S., Union City, N. J.

The drift on channel 13 which you mention could be due to improper tuner tracking or misalignment of the video i.f. stages. Improper tracking and alignment usually result in more critical performance on the upper channels because normal oscillator drift has a more pronounced effect on the higher frequencies. If the bandwidth is too narrow, normal oscillator drift will not be so noticeable on the lower channels, but would be on the higher. This is particularly true if lower channel stations are being received better than the higher. Stations from some distance also fade out on occasion. In either case (oscillator drift or fade-out) the signal-to-noise ratio decreases and the result is increase in noise and picture interference. With volume control and contrast up high, the low signal-to-noise ratio becomes serious. Automatic gain-control circuits work in this fashion also—with no signal input, the resultant low bias on the amplifier tubes increases gain and also noise, with no signal riding through.

Try adjusting the sound and picture output trimmers on the tuner—these may not be giving you good match between tuner and i.f. stages. On the Sarkes Tarzian tuner channel 13 screw adjustments are on the top for r.f. grid, r.f. plate and mixer grid circuits. Channel 13 oscillator screw adjustment is on front. Try several different r.f. tubes also. Some give a better signal-to-noise ratio than others, which means decreased snow effect.

—end—

Meters Properly Used Aid Trouble Shooting

Basic v.t.v.m. and multimeter circuits described with a few hints for their accurate use.

By RUDOLF F. GRAF

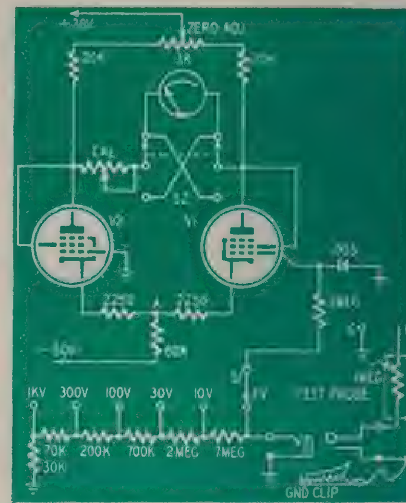


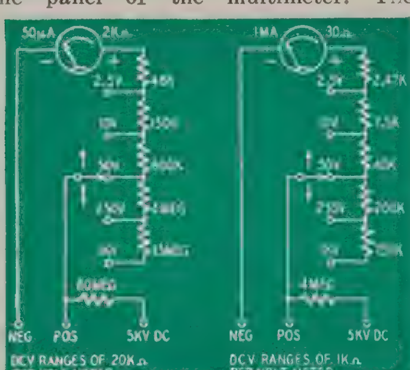
Fig. 3—D.c. voltmeter part of VTVM.

AS RADIO and television circuits increase in complexity, the troubles of the repair man increase with them. Even the meters he has always used seem to fail him at times. Service manuals or schematic diagrams generally indicate the proper voltages at various points of the circuit. But different and sometimes greatly confusing results may be obtained in some parts of the circuit if the meter used is not the same type as the one used to make the original measurement. The two basic types of meter today are the vacuum-tube voltmeter and the multimeter. We shall briefly explain the operation of both types, and then compare the readings obtained by each type in the identical circuit.

Multimeters

This type of meter has until recently been the more popular of the two. It has the advantage of being rugged; it is less expensive than the v.t.v.m. and generally is completely self contained. (No need for connection to a.c. line.) Its usefulness is limited, however, as we shall point out later.

All the so-called multimeters employ a basic D'Arsonval meter movement which is connected to various resistors. These resistors are selected either with a switch, or by connecting the test leads to any two of a number of pin jacks on the panel of the multimeter. The D'Arsonval movements used in multimeters require anywhere from 25 microamperes to 5 milliamperes of direct current for full-scale deflection. The less current required for full-scale deflection, the more expensive is the meter movement and hence the complete instrument. The voltmeter ranges are always specified as having a certain "ohms-per-volt" rating. This is determined by the basic sensitivity of the meter movement used.



a b

Fig. 1—D.c. volt ranges: (a) 20,000-ohms-per-volt meter; (b) 1,000 ohms/volt.

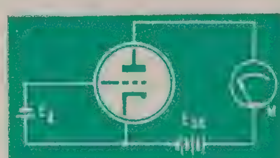


Fig. 2—Fundamental circuit of a VTVM

Fig. 1-a shows the d.c. voltmeter ranges of a popular multimeter (the Simpson model 260) which has a sensitivity of 20,000 ohms per volt. We shall now see how the voltmeter sensitivity is determined.

The basic meter movement used requires 50 microamperes for full-scale deflection and has a resistance of 2,000 ohms. If we wish to use this meter movement to indicate full scale when measuring 2.5 volts, we must arrange the circuit in such a fashion that the current through the meter will be 50 microamperes. By dividing 2.5 volts by 50 microamperes we find that the total circuit resistance must be 50,000 ohms. Since the meter movement itself has a resistance of 2,000 ohms, we need only to add a 48,000-ohm resistor and we are ready to measure all d.c. voltages up to 2.5 volts. Anything less than 2.5 volts will cause a correspondingly lower current and hence will be indicated on the meter scale as a smaller voltage. We can measure any higher voltage as long as we keep sufficient resistance in the circuit to limit the maximum current through the meter at all times to 50 microamperes. This particular multimeter has full-scale ranges of 2.5, 10, 50, 250, 1,000, and 5,000 volts d.c. As can be seen from Fig. 1-a, the higher voltage ranges are obtained by simply adding resistors in series to those already in the circuit. These resistors are called multipliers.

To determine the ohms per volt all we have to do is divide the full scale voltage of any one range into the total resistance in the circuit at that particular range. For example on the 50-volt range, the ohms per volt equals 1,000,000 divided by 50. (We get 1,000,000 by adding all the resistances; namely 800,000, plus 150,000, plus 48,000, plus 2,000-ohms.) This comes out to be 20,000. Actually a more correct designation would be "ohms per range volt," since for every volt on any one range the meter has a resistance of 20,000 ohms.

The voltage under test is applied between the POS and the NEG terminals and we can see that the resistance which will be presented to the circuit under test will be different for every voltage range. It is lowest on the lowest range (50,000 ohms) and highest on the highest range (100,000,000 ohms). This variation of input resistance is shown in Table I.

Fig. 1-b shows a schematic of the d.c. voltage circuit of a meter having the identical ranges of the above instrument, but employing a meter movement whose full-scale sensitivity is only 1 milliampere. In this case the multipliers are much lower in resistance than those we had before. The sensitivity of this meter is easily found to be 1,000 ohms per volt. The input resistance on all ranges is much lower than for the 20,000-ohms-per-volt meter, and is also shown in Table I.

From these two examples it can be seen that the ohms per volt of a meter depends strictly on the basic movement used. The more sensitive the basic movement, the higher the ohms per volt. Now let us look at the other type of meter, the v.t.v.m.

Vacuum-tube voltmeter

A vacuum-tube voltmeter is, as its name implies, a voltmeter using one or more vacuum tubes. A circuit of a basic v.t.v.m. is shown in Fig. 2. The meter is so connected that it measures plate

current. If we change the grid voltage E_g, this voltage change will cause a change in plate current and hence a change in meter reading. Since the grid circuit of a vacuum tube does not require any power if it is not permitted to go positive, we have an instrument which will give us a meter reading without requiring any power from the circuit under test. This is the fundamental advantage of a v.t.v.m.

We recall that in the multimeter we had to have a current through a resistance. It was the current which caused the meter needle to deflect. This requires power (I^2R) which, though it is small, must come from the circuit under test.

In recent years almost all v.t.v.m.'s have used a very stable 2-tube bridge circuit. The essential components of the d.c. voltage circuit of Electronic Designs, model 100 v.t.v.m., are shown in Fig. 3. The instrument uses two triode-connected 6K6 tubes which are linked together by a 60,000-ohm resistor which is common to both cathode circuits. The meter is connected between the two plates to indicate any potential difference that may exist. If there is no voltage applied to the grid of V1 the circuit will be exactly balanced due to its symmetry. The plate currents of both tubes will be exactly the same, the potentials at both plates will be equal, and the meter will read zero. The 3,000-ohm zero-adjust potentiometer is used to balance out any slight difference in tube characteristics or component values which may exist in the unit. If the grid of V1 is made positive, the plate current of this tube will increase.

Increase in the plate current of V1 will make point A more positive. This will also cause the cathode of V2 to become positive and hence *decrease* the plate current of that tube. So we see that an increase in plate current of V1 causes a decrease in the plate current of V2. Due to the different plate currents there will now exist a potential difference between the plates of the tubes, and the meter will deflect. The amount of deflection depends on the difference in potential, which, in turn, depends directly on the magnitude of the voltage applied to the grid of V1.

If the voltage applied to the grid of V1 is negative, the plate current of this tube will decrease, point A will become less negative, and the plate current of V2 will increase. There will again be a potential difference between the two plates, but this time in the opposite direction. In order to be able to employ a left-zero meter, it is necessary to incorporate in the instrument a reversing switch by means of which the polarity of the meter movement can be reversed so as to have the meter read "up" at all times. This reversing switch is shown as S2 in Fig. 3. The voltage for the grid of V1 is obtained from a voltage divider consisting of R1 to R6. This voltage divider applies approximately 3 volts to the grid of V1 to obtain full-scale meter deflection. The voltage being measured is applied between the terminals P and G, and S1 picks off a portion thereof and applies it to V1.

A 1-megohm isolating resistor is incorporated in the d.c. test probe to reduce the input capacitance of the meter. This isolating resistor offers the advantage of permitting the measurement of d.c. voltages at points where r.f. voltages are also present, without detuning the circuit to any appreciable extent. The resistance presented to the circuit under test is constant and remains at 11 megohms regardless of the range.

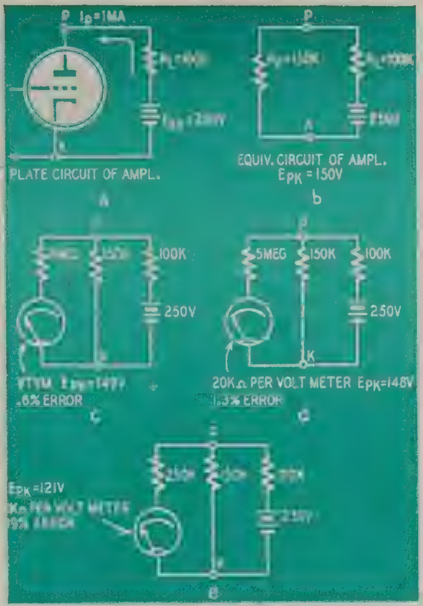


Fig. 4—Errors in measurement, where E_{pk}=150. (c) .6%, (d) 1.3%, (e) 19%.

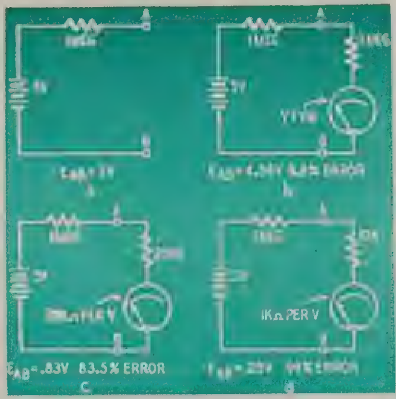


Fig. 5—Circuit measurement errors: (b) 8.8%, (c) 83.5%, (d) 99%.

Suppose we now want to find the ohms per volt as before, by dividing the full-scale voltage by the resistance in the circuit. Referring to Table II, we see that the ohms per volt of the v.t.v.m. is different for every range. We find the highest ohms per volt on the lowest range, and the lowest on the highest range. We say, then, in Table II, ohms per range volt. It may be interesting to note at this point that on the 1,000-volt range a 20,000-ohms-per-volt meter has a greater sensitivity (less circuit loading) than the vacuum-tube voltmeter. But since most servicing does not require the use of the 1,000-volt scale, it is still preferable to use the VTVM.

Table I

Voltage range	Input resistance	
	20,000 ohms/v	1,000 ohms/v
2.5 v	50K	2.5K
10 v	200K	10K
50 v	1 meg	50K
250 v	5 meg	250K
1,000 v	20 meg	1 meg
5,000 v	100 meg	5 meg

Table II

Voltage range	Ohms per range volt
3 v	3.65 meg
10 v	1.1 meg
30 v	365,000
100 v	110,000
300 v	36,500
1,000 v	11,000

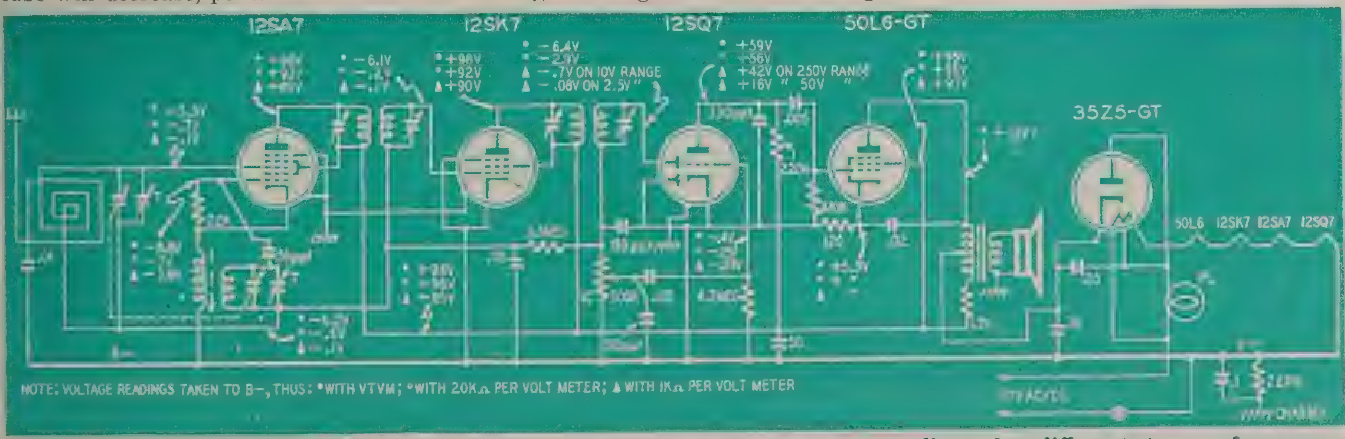


Fig. 6—Schematic of 5 tube a.c.-d.c. receiver with comparative voltage readings for different types of meters.

Using meters

Now let us observe the voltage readings at a point in a circuit, using different types of meters as voltage indicating devices. Fig. 4-a shows the plate circuit of a voltage amplifier having a load resistor of 100,000 ohms, a plate current of 1 ma and a B-voltage supply of 250 volts. Fig. 4-b shows the equivalent circuit with the tube replaced by R_p. Under the above conditions the voltage which will exist between the plate and cathode of the tube is 150 volts. To measure this voltage the meter must be connected between points P and K as shown in the illustration. Three different types of meters are shown connected, 4-c, 4-d, 4-e, and the readings obtained as well as the percentage of error are shown. The 1,000-ohms-per-volt meter will give a reading of 121 volts instead of the 150 volts which is actually on the plate when the meter is disconnected. Thus, the error in reading is almost 20%. The other two meters will give readings which are closer to being correct.

The errors introduced become much more severe when we attempt to measure voltages on circuits whose resistance becomes appreciable when compared with the resistance of the meter on the range employed. An illustrative example is shown in Fig. 5 which involves a circuit whose resistance is 1 megohm and whose open circuit voltage is 5 volts. As before, the readings obtained, as well as the percentage of error are shown. We can very easily see that under these conditions the low ohms-per-volt meters are quite useless.

Fig. 6 shows a typical superhetrodyne receiver, RCA 65X1, with voltage readings. There are three voltage readings at all critical points and where there are two for the same type of meter, different ranges were used as indicated. It is evident from these readings on the grids of tubes and on the a.v.c. line that the 1,000-ohms-per-volt meters can not be used as an indicating device, and that in most cases a v.t.v.m. should be used if at all possible. Of course, a stable v.t.v.m. is required. In manufacturers' servicing instructions you will generally note that the type instrument employed for taking voltage measurements is mentioned. The above article has been written with the hope that it will clarify and help account for some of the inexplicably "wrong" voltage readings which may have been obtained in perfectly normal and well-operating equipment.

It will only take a little forethought on the part of the meter user to often save a great deal of time and effort otherwise expended in making the "wrong" meter reading fit a "good" circuit. So let's not blame the meter if it will not measure anything beyond the point for which it has been designed. Let's follow the manufacturer's recommended procedure.

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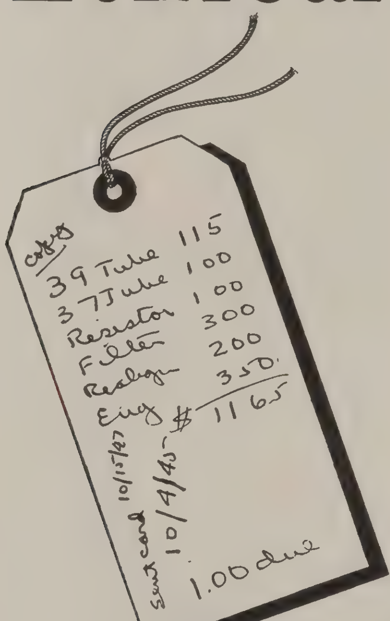
Ethical Service Pays Off

By WALTER R. ROGERS



High repair estimate tag; everyone loses.

NOT too long ago, when returning from lunch with three fellow workers, we spotted a friend rummaging around some trash barrels. It was rather strange, to say the least, to see Charlie at such an occupation. But when he saw us and invited us to see what he was up to, there were five of us in the junk business. Here were some 15 radio sets, more or less complete, tagged and waiting for the city trash trucks to haul off.

A casual look showed most of them complete and a few bashed in as if dropped. For the fun of it, each of us dragged back to the shop with a set or two. Each was tagged with customer's name, address, date, and a repair tabulation which was higher than the value of the set. Charlie had time—before going to work—to replace a defective a.c. plug. The set worked right off with no real servicing at all. That night I left my set with another service technician just to see what he would do with it. It took 12 minutes to find an open coupling capacitor and align the set at the cost of $1.50 at his regular prices. This set is playing in our kitchen in spite of the tag, similar to that shown in Fig. 1. No wonder the former owner gave up this little a.c.-d.c. set after the estimate of $11.00 when new sets cost only a couple of dollars more.

Other genial weaknesses

There is no excuse for a radio service technician, because of his superior knowledge of radio, to take a "public be damned" attitude, appearing in dirty clothes and leaving a mess behind. The customer is paying for his time and the customer expects to receive protection of property and a decent cleaning up when the service technician is through.

In one locality, an electrician and a plumber are on the customers' preferred list because they always clean up after a job and are considerate of all wishes of the customer. I have never heard an objection to the slight charge which covers this time and makes each job pay a little more.

There is no question as to the need of genuinely professional radio service. How can it best be accomplished with the least red tape? Authorized service for certain makes of sets can be a factor in larger cities. But in the smaller cities and towns, a radio service shop must take on anything that comes over the counter. There are many of these fellows who may only have a small sign out front and do their repairing at night and on week-ends.

As a starter, how about bonding radio service establishments in such a way that both they and the customer are protected from abuses? (At least one manufacturer has set up a bonding program in an attempt to meet this need.—*Editor*) A small fee must be added one way or another to each job, and the final arbiter of disputes would be the local Chamber of Commerce, Board of Trade, or Better Business Bureau. A reasonable code of ethics would be agreed on, publicized, and displayed by all radio service technicians who were able and willing to comply. Even the set manufacturers, through the RMA, might help further such a bonded service, in a manner that would not discriminate against the smaller service technician but that would make radio servicing a *real service to the public.*

Reasonable allowances must be made. For instance a reasonable minimum must be charged and rates so adjusted that the occasional tough job can be covered. There is a public service that any profession must undertake, and those who have gained solid public acceptance know what I mean. Price, quality of service, and speed of repair must be tempered with reasonable business practice and fair dealing.

What do you think would be the best way to make servicing a more responsible profession?

—end—

The Useful Impedance Bridge

By RICHARD H. DORF

VERY few radio service technicians, experimenters, or amateurs today feel that they can get along without test equipment. Even the "screwdriver" service operator has at least a voltohmmeter and a signal generator; to these the technician, experimenter and amateur may add audio oscillators, frequency meters, and similar equipment.

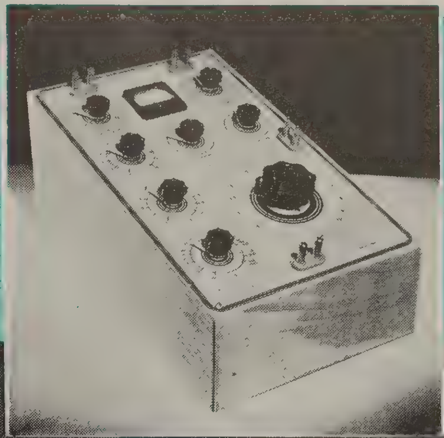
The majority of radiomen, however, are still forced to guess at the true value of a capacitor or measure it by the inaccurate impedance method on a v.t.v.m. And very few radiomen have any way at all of approximating even vaguely the inductance of a reactor. With the advent of television, the guess method is on its way out, for in many circuits only correct values will work at all.

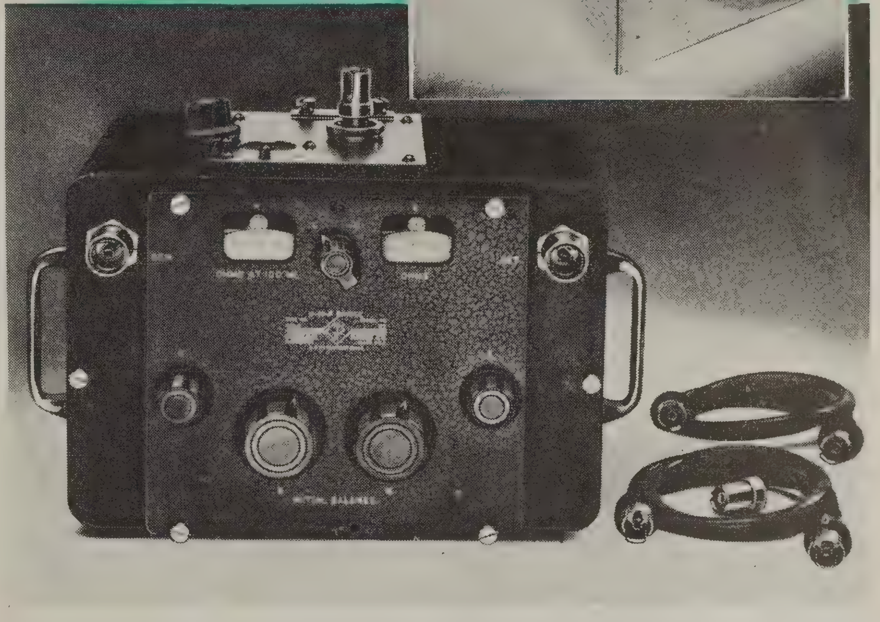
The hobbyist and amateur have always had trouble constructing devices using capacitors and inductors, particularly the latter. Ordinary values as marked do very well for filter and bypass capacitors and filter chokes; but when a filter or tone control or a loudspeaker crossover network or any of many devices requiring accurate values of C and L is to be built, where are the inductors to come from? Filter chokes have other than rated inductance with no d.c. flowing through them. Audio inductors of the correct values are expensive. The usual practice is to start removing turns from an old choke whose initial inductance may not even be known.

It is easy to calculate the correct inductance for receiver and transmitter coils, but winding them is something else again. If clear directions are given in a magazine article, the results *may* be close, but often, it is necessary to rewind them altogether—after installation. And what of those old variable capacitors in the junk box—how can their capacitance be found? And what happens when a low-resistance shunt is needed for a meter? The voltohmmeter will measure none of these with useful accuracy.

The answer is the impedance bridge. For many years the bridge has been strictly a laboratory instrument, but it is gradually finding its way into the service shop and onto the basement bench.

A bridge that will measure resistance, capacitance, and inductance, with Q of inductors and dissipation factor of capacitors, is not impossible to build; it requires no vacuum tubes or high-voltage supply. It does, however, require careful attention to rigid wiring, and a minimum of stray capacitance and resistance.





Two typical commercial impedance bridges are illustrated. The Heathkit comes in kit form; the GR unit factory wired. Both are accurate, flexible instruments.

The constructor may either purchase a kit or obtain his own parts. In the latter case only the highest quality parts should be purchased. For instance, switches should be ruggedly constructed, with heavy silver-alloy contacts. Low-tolerance parts are essential. Bus wire should be used throughout.

A commercial, proved circuit was used by the author (see Fig. 4). Figs. 1, 2, and 3 are simplified diagrams extracted from Fig. 4 for explanatory purposes. Resistance, capacitance, and inductance measurement procedures will follow below in that order.

Resistance measurement

A bridge operates by comparing the component to be measured with a standard rather than by observing its effect on current flow as in a voltohmmeter or v.t.v.m. As a result, the inaccuracy introduced by variations in a power supply or by a meter movement are avoided.

Fig. 1 is the circuit of a Wheatstone bridge suitable for measuring resistances from about .005 ohm to 10 megohms. (See Fig. 4 for significance of range switch position.) The important components are the resistors attached to S1-a and S1-b, which must be very precise (they are ±0.5% in one commercial bridge) and the 10,000-ohm variable resistor, which is calibrated to read the unknown values. The 10,000-ohm resistor has an approximately logarithmic taper. It must be wire-wound for good accuracy and long wear. Special units are usually used in bridges, the ones made by General Radio being most common.

The zero-center galvanometer has a movement of 100 μa each side of center. S3-b places a 100-ohm shunt across it to reduce its sensitivity during the initial balancing.

The bridge in the top photograph has the dial of the 10,000-ohm variable resistor calibrated in large units. The markings are simply in thousands of ohms, arranged so that when the pointer is at 1, for instance, the arm is set for a resistance of 1,000 ohms. The ranges

marked in Fig. 1 for S1-a and S1-b are in multiples of 10 so that all can use the same main dial markings.

For measuring resistors S2 is usually set on DC so that the 6-volt built-in battery voltage is applied through a 68-ohm current-limiting resistor to the bridge input. The unknown resistor is connected to the R terminals as one arm of the bridge. Let us assume that the unknown is 1,000 ohms.

Setting S1 to the 1,000-ohm range (*E*) we find that the total resistance between points *X* and *Z* is 10,000 ohms.

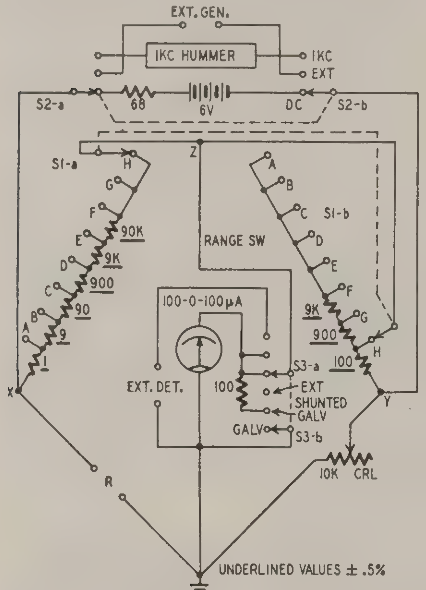


Fig. 1—Wheatstone bridge measures resistance. Battery or hummer is used.

Between *Z* and *Y* is also 10,000 ohms. Therefore exactly one-half the battery voltage appears between *Z* and either *X* or *Y*. If we then set the potentiometer to 1,000 ohms, one-half the battery voltage appears between ground and either *X* or *Y*. Thus, points *Z* and ground are at exactly the same potential and the galvanometer will draw no current. In operating the bridge, the potentiometer is first set for a near-zero meter reading, then the meter shunt is removed with S3-b to make the meter more sensitive so that it can be zeroed more exactly.

Suppose now that a 500-ohm resistor is to be measured on range *D*. On that range the resistance from *X* to *Z* is 1,000 ohms; from *Z* to *Y* is 10,000 ohms; the ratio is 1 to 10. If the same ratio is held for the other two arms, the voltages at *Z* and ground will again be equal for zero meter reading. To make it so, the potentiometer must be set at 10 × 500 or 5,000 ohms. The pointer is then on the 5 mark. Multiplying the range switch setting (100) by the potentiometer dial reading (5) gives the correct resistance of the unknown (500).

On the very high and very low ranges the current through the meter when the bridge is slightly off balance is very small, making it difficult to set the potentiometer exactly. The solution is to substitute a higher voltage for the built-in battery by connecting an external source to the EXTERNAL GENERATOR terminals and switching S2 to its center position. On the *A* through *D* settings of S1, a maximum external voltage of 67.5 may be used with a series current-limiting resistor of at least 1,500 ohms. On the *E* position, 135 volts may be used with at least 4,000 ohms in series. On the *F*, *G*, and *H* ranges, 202.5 volts is the maximum, with at least 6,500 ohms series resistance.

The 1,000-cycle hummer used for L and C measurements can also be used for R measurement, with a set of headphones connected to the external detector terminals, setting the bridge for a null in the phones.

Capacitance measurement

The circuit given in Fig. 2 measures capacitance from about 10 μμf to 95 μf and does it accurately, *provided the wiring does not add stray capacitance.* The writer has measured calibrated capacitors as small as 15 μμf, a value with which almost no v.t.v.m. instrument will cope. S1-a, its resistors, and S2-a and -b are the same units shown in Fig. 1. The same 10,000-ohm potentiometer and dial scale are used as well.

A capacitor has two important ratings, capacitance and power or dissipation factor. Capacitive reactance alone does not consume power, but since no dielectric is a perfect insulator, all dissipate some power.

The dielectric resistance across the capacitance is usually very high. In a bridge we must duplicate the effect of this high shunt resistance on the standard capacitor. Using a high-resistance potentiometer (sometimes of several hundred megohms) is impractical. The same effect is obtained with a *low resistance in series.* This produces the same change in net impedance and the same power loss as a high resistance in parallel.

In Fig. 2 a 1,000-cycle hummer powered by the 6-volt battery or an external audio oscillator furnishes a.c. for the bridge. A hummer is an electromagnetic buzzer-like device especially made for this purpose. It eliminates the need for a vacuum-tube oscillator. The .01-μf capacitor (accurate to within ±0.5%) is a standard with very low dissipation factor.

In operation, the unknown capacitor is connected to the C terminals. The range switch and the 10,000-ohm main potentiometer are adjusted so that the impedance ratios are equal, just as in the resistance bridge. The net impedance of both the standard and unknown capacitors depend not only on capacitive reactance but also on the resistance. Two variable resistors with dials marked *D* are provided in series with the standard capacitor to provide for dissipation or power factors from 0.1 to 1. Power factor is the ratio of actual watts of power consumed to volt-amperes (voltage drop across the capacitor times current through it).

The two D dials may be calibrated from 0 to 10 linearly (if the resistors have a linear taper). They are read as .01-0.1 and 0.1-1, as indicated in Fig. 2. Set the knobs so that each resistor is exactly in the middle of its resistance range with the pointer on 5.

When measuring a capacitor, the final settings must be made with the D and main dials at the same time, setting both for a null in the headphones.

Inductance measurement

The diagram of Fig. 3 actually shows two different bridge circuits for measuring inductances from 5 μh—100 h. With S4-a closed the circuit is a Maxwell bridge for inductances with Q of 0 to about 10. With S4-a open and S4-b closed, the circuit becomes a Hay bridge, taking care of Q from 10 to about 1,000.

The dissipation factor of a capacitor is usually very low and has little effect on its circuit. On the other hand, resistance in coils of all kinds is usually very important. It is due to the wire with which the coil is wound. The Q of an inductor is its factor of merit and is the ratio of inductive reactance (at a given frequency) to ohmic resistance. Q determines the shape of resonance curves and the steepness of cutoff in filters, among other things.

With S4-a closed, the 16,000-ohm variable resistor is across the standard 0.1-μf capacitor (made up of 10 .01-μf units).

The unknown inductor is placed in the diagonally opposite bridge arm instead of in the adjacent one, as with the unknown capacitor of Fig. 2, because inductive reactance is opposite in sign to capacitive reactance. The bridge is adjusted to a rough balance with the range switch and the 10,000-ohm main control. Then the 16,000-ohm resistor is adjusted for minimum sound output. Final balance is obtained with both controls. Inductance is read from the main control dial and the range switch; Q is

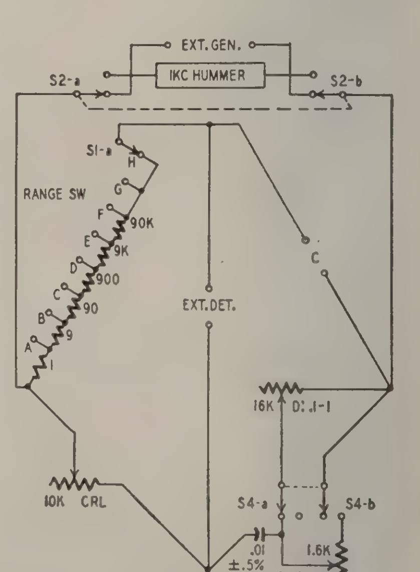
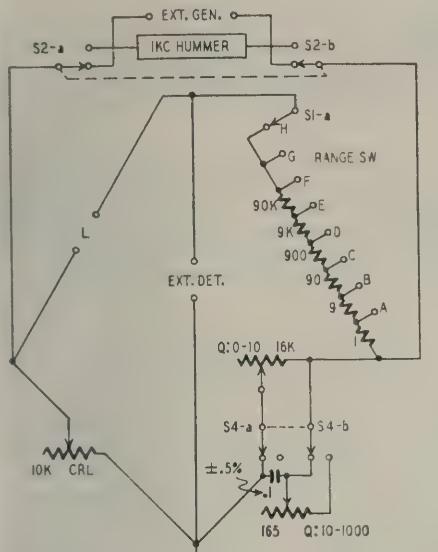


Fig. 2—This circuit measures capacitor values for all but electrolytic units.



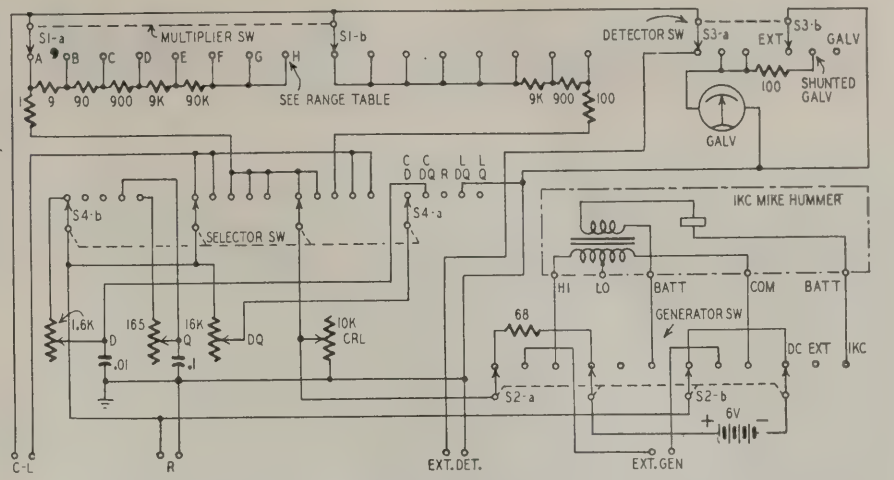


Fig. 3—left. Hay and Maxwell bridges selected by S4 measure inductance and Q.

Fig. 4—above. Switch numbers of Heathkit schematic are same as in Figs. 1, 2, 3.

read from the 16,000-ohm resistor dial.

When balance is impossible in this way, the 165-ohm potentiometer is switched in series with the standard capacitor. It accounts for Q of 10 or more, corresponding to low coil resistance. The same procedure as above described is applied. The series resistance (of a higher value) could be used even for low Q, but a high resistance in series with the capacitor would alter its impedance enough to make the bridge frequency-sensitive.

Fig. 4 is a complete schematic diagram of the Heathkit impedance bridge used by the author. It contains the circuits of Figs. 1, 2, and 3. Heavy bus wire is used for all connections except for the battery and hummer, to keep stray capacitance, wiring resistance, and instability low. New bus wire should be stretched first to make it straight. Put one end in a vise and pull hard on the other end with a pair of pliers until the stretch is felt. Make each connection mechanically sound.

RANGE CHART

Range	R	C	L
A	.005-1.0 ohm	0.5-100 μf	5-1,000 μh
B	.05-10 ohms	.05-10 μf	.05-10 mh
C	0.5-100 ohms	.005-1 μf	0.5-100 mh
D	5-1,000 ohms	.0005-0.1 μf	5-1,000 mh
E	50-10,000 ohms	.00005-.01 μf	50 mh-10 h
F	500-100,000 ohms	5-1,000 μμf	0.5-100 h
G	5,000 ohms—1 meg.	—	—
H	.05-10 megohms	—	—

Main dial calibration of the kit job is simple. In the kit the panel is already marked; it is necessary only to set up the bridge for resistance measurement, using as the "unknown" a 1,000-ohm standard resistor supplied.

Without the kit, another bridge can be used to measure the resistance of the 10,000-ohm unit at several points, after which the dial is marked in thousands of ohms. The knobs for the Q and dissipation factor controls then may be oriented by measuring their resistances with the bridge itself.

In using the inductance ranges, remember that the Q reading is accurate only for the frequency at which it is measured. For use at frequencies other than 1,000 cycles S2-a and -b (Fig. 4) may be switched to the external generator position and an external signal of the correct frequency applied. Inductance readings are reasonably accurate at all frequencies even though taken at 1,000 cycles, but r.f. resistance at higher frequencies will lower the Q of most coils, and results are unreliable. Special bridges are required for high radio frequencies.

Capacitance readings may be relied upon at all but the very highest radio frequencies where capacitors become inductors because of the leads and so on. Resistance is accurate for all frequencies, but wire-wound units may become inductors at high frequencies.

—end—

Battery Checker Gives 6 Different Tests

The Army Signal Corps Engineering Laboratories, Fort Monmouth, N. J., have developed a storage battery checker which combines numerous functions and tests which previously required several separate checkers.

Certain Signal Corps batteries don't have more than a teaspoonful of acid in their cells in case a hydrometer is used, literally, there isn't enough acid to be tested by the float method. The new tester gives an electrical rather than a chemical test. The basic principle and design, worked out by Grenville Ellis, chief of the Laboratories Power Services branch, was incorporated in the developmental model built by Hickok Electrical Instrument Co., Cleveland.

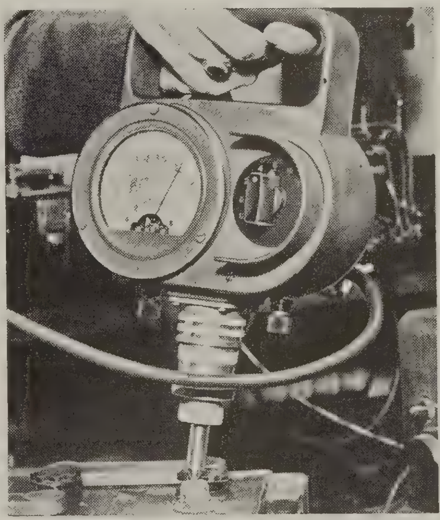
Problems in testing the batteries which might be used throughout the world are complicated because to get maximum performance, batteries in the Arctic zone are given a higher specific gravity acid, while in tropical zones, the specific gravity of the acid is reduced to prolong the battery life span. Ordinary testers can test batteries designed only for temperate climates.

The following is an explanation of the scales on the dial face:

VOLTS: All scales on the dial are based on voltage scale. Voltages are measured under no-load or load, depending on test required.

FREEZING POINT: This tells at what temperature the battery acid will freeze. It ranges down to –85 degrees F.

PERCENTAGE OF CHARGE: This is based on open circuit tests and there are scales for Tropic, Normal, Arctic; since percentage of charge remaining is a measure of the specific gravity, and different specific gravity is necessary in separate climates, three scales are necessary.



CHARGING VOLTAGE: (to right of percentage of charge). This tests the battery under charge, and tells whether the battery is charging at the proper rate.

LOAD TEST: This is based on a closed-circuit test, and shows whether it is working properly under load. The dial at the right of the meter selects the load. If used in an auto (mounted on dash or steering wheel) the vehicle supplies the load. There are three sections to the load test, +80° F.; 0° F.; and – 40° F.

CRANKING TEST: This is a high rate load test at high current. It tells whether there is enough juice to start the engine and has two sections, 0° and – 40° F. —end—

Servicing the AM Receiver

Eliminating minor troubles in i.f. or r.f. stages; realignment pays off in better set performance.

By J. TRAVIS RODGERS

THE ability of a receiver to pull in weak signals and to separate stations which are on adjacent channels depends, in most cases, on proper alignment of all tuned circuits. Realignment of the average set is no problem for the technician. The real headaches arise when one must track down and eliminate minor troubles in the i.f. or r.f. circuits before the set can be correctly aligned.

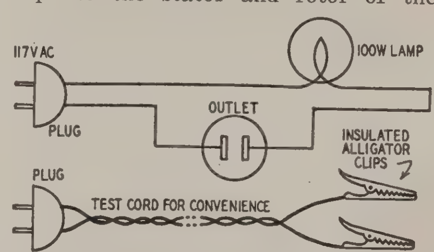
If a set oscillates badly over part or all of the band, and peaking the i.f.'s at the correct frequency does not eliminate the trouble, the next logical step is to check for an open a.v.c. or screen bypass capacitor. In large a.c. sets, an open or partially open filter capacitor may be the cause of oscillations, even though it is not bad enough to cause noticeable hum. Close coupling between grid and plate leads in r.f. or i.f. stages also may be the source of trouble. Moving these leads around with an insulated tool may lengthen the feedback path and eliminate oscillations.

Recently I spent some time going over a practically new radio—one of RCA's miniature-tube models. Oscillation was so bad that it was impossible to send a clear signal through the set. After considerable manipulation, I noticed that oscillation stopped when the tuning capacitor was wide open. A close examination showed a few drops of water between the plates. The set had been left by an open window during a rainstorm. The water was removed by sliding a strip of blotting paper between the plates. Oscillation vanished and the set was realigned without further trouble.

Another annoyance is excessive static. A comparison with a set known to be in good condition will quickly reveal whether the noise originates in the set or is caused by atmospheric conditions or power-line disturbances. If the noise is produced or intensified by jarring the set, the chances are good that it is due to a loose connection, faulty tube, or coupling capacitor. Tapping these parts or moving them slightly will usually disclose the source of the noise. If the disturbance is a popping or crackling sound, it may be the result of a partially shorted or open winding on a transformer. Of course, the output transformer can cause this trouble, but it is more likely to be the primary of the oscillator coil or an i.f. transformer. Momentarily shorting to ground the plate side of each coil will send excessive current through it. This will usually result in the leak being healed or will cause the winding to completely open up so it can be located and replaced.

Often static is noticeable only when the tuning dial is moved. This is probably the result of the tuning capacitor plates rubbing or the presence of dust or metal particles between the plates. If the plates are rubbing, they usually can be straightened with a little patience and effort. Foreign particles usually can be removed with a blast of air or a small paint brush. If this does not work, try the gadget shown in the diagram.

Be sure to disconnect the r.f. and oscillator coils before using this device. If you don't, the coils will be damaged. Plug in the test leads and connect the clips to the stator and rotor of the capacitor. As the tuning dial is turned, the lamp will glow or burn brightly as the foreign material is burned out. If the lamp remains lighted there is a direct short between the plates. Sparking between the plates when contact is made or broken will show the exact location of the short. Some prewar sets have chrome- or nickel-plated capacitor plates. The plating often peels and causes no end of trouble. This gadget is the most effective means of removing plating which has peeled or scaled.



How to spot shorted variable capacitors.

Alignment procedure

Poor selectivity, low volume, tuning stations at the wrong point of the dial, sensitivity fair at one end of the dial and poor at the other, and a tendency to oscillate are all indications of misalignment. Assuming that tubes and other components check O.K., we are ready to align the set. **If you do not have a signal generator, get one!** All this ballyhoo about aligning radios without a signal generator is the bunk. Even if it can be done fairly accurately without a generator, it is neither practical nor profitable.

It is well worth the time to look up the correct intermediate frequency before attempting the job. If the data is not available, the correct i.f. usually can be found by trying the most common i.f.'s (175, 262, and 456 kc). Most sets are better aligned with the tuning dial set to the low-frequency end of the band. When a signal comes through clearly, try tuning set and generator across the dial. If the signal continues to be heard at a constant level, the i.f. is O.K. If it peaks at several points on the dial, try another i.f.

An output meter is a worth-while piece of equipment to have but is not essential. If you have a sensitive ear, you can do a good job without one.

If a strong broadcast station comes in at the correct spot on the dial, it can be used instead of a signal generator for aligning the r.f. and oscillator. The most common procedure is to align the oscillator trimmer at around 1600 and the r.f. trimmer or trimmers at 1400 kc. If an oscillator padder is used, it should be adjusted for maximum output at around 600 kc. This adjustment should be made while rocking the tuning control. Repeat this procedure until tracking is correct at both ends of the dial.

In the Communications section some time ago, a reader voiced his disapproval of technicians who bend tuning capacitor plates instead of adjusting trimmers. I agree with him as a general rule; however, some sets—particularly small a.c.-d.c. models—cannot be aligned without bending the plates.

Because of some peculiar change in circuit constants, some sets have entirely too much capacitance in the tuned circuits to permit the stations to be tuned in at the correct spot on the dial when the i.f.'s are correctly peaked. I balance this condition by unwinding a few turns from the oscillator or antenna coil, or a single turn from the loop. This usually results in increased volume and better selectivity and stability. Take care that you don't remove too many turns and reach the opposite extreme. Removing the necessary turns sometimes turns out to be quite a job, so an additional charge is in order when this is necessary.

Some customers may argue against paying a nominal fee for alignment until they see how their sets have improved. Afterward, they go away contented with the job. Customer confidence and good-will build up repeat business.

—end—

The Ship Radio Operator

Opportunity beckons in the merchant marine radio service

By AARON NADELL

Radiomarine Corp. of America

Radio room of the *S.S. Independence*, with Radio officer Charles C. Berger on duty.

PRESENT international tensions reopen the opportunity, normally scarce in peacetime, for radiomen to serve their country in civilian status—and see the world, gain interesting and valuable experience, and enjoy a good income—as radio officers aboard ships of the merchant marine. Men who do this work are also draft-exempt; at least they were doing the two previous world wars.

The work itself is not strenuous. It is pleasant, interesting, and decidedly well paid according to present rates of pay for radiomen in shore jobs. It provides endless opportunity for travel, to get out of the rut, to break with routine, to see far and wonderful places, where life and people are different.

There is ample opportunity for advancement in the sense that the radio officer has an abundance of spare time that he can use for studying correspondence courses in his own profession or any other field, if he so desires. And there is excellent opportunity for a well-paid lifetime career of sailing the seas, if the radioman cares to convert this temporary opportunity into a permanent place among the country's professional merchant seamen.

Minimum pay at present is about $350 a month. There are additions, which ordinarily operate to raise the real pay to between $400 and $500 a month (plus room, board, and travel).

Note that this is civilian, not service pay. There are no service benefits: for example, no allowances for dependents. The radio officer supports his own, if he has any. Income tax concessions and other privileges granted to members of the armed forces also do not apply. There are some seamen's privileges; the R.O. can buy stand standard brand cigarettes aboard at 70 cents a carton or thereabouts; and razor blades, work clothes, and other small items at cost.

The radio officer is licensed. He may at any moment find the ship's safety, and the life of everyone aboard, in his own two hands. Not everybody is allowed to take on that responsibility. The United States Government licenses those who pass appropriate examinations for competence. The average radioman, however, has nine-tenths of the background needed for the technical examination and can easily acquire the rest. If he does not know the International code, or first aid, he will have to train himself in those matters.

Three kinds of ships

There are three types of American merchant ships: dry-cargo, tanker, and passenger. The passenger ships are publicized and glamorized to attract customers, but in the American merchant marine they are a very small minority. A number of dry cargo ships and tankers, however, do earn extra money for their owners by carrying a few passengers also—in some cases no more than half a dozen.

Backbone of the merchant marine is the dry cargo freighter. This is simply a seagoing truck. Just as some trucks on the road move general merchandise for anybody who wants to ship it and go wherever they are needed, so there are dry-cargo freighters (and tankers also) called "tramps" because they have no steady runs but go wherever they can find cargos. On the road there are also fleets of trucks that are owned by one corporation and carry that corporation's goods only. Similarly there are ships and fleets of ships that carry only aluminum ore, or sulphur, or bananas, for corporations dealing in those commodities.

The U. S. merchant marine also includes a large number of tankers. These are like gasoline trucks or milk trucks—built to carry fluids, usually crude oil. Some oil companies own large fleets of tankers.

Life on the deep sea

The radio officer's life on shipboard, outside his working hours, depends a good deal on the kind of ship he rides. On freighters and tankers, especially those carrying no passengers, matters are usually informal. More like a stag camping party than like business ashore. Even the captain does not always trouble to shave. Any kind of working clothes are acceptable; nobody thinks of wearing a necktie until the ship approaches port. Discipline is easy-going—the captain is "Sir" or "Captain," the chief engineer is "Chief"; the mates and engineer officers are called either "Mr. So-and-so" or by their first names. However, the first assistant engineer is sometimes "First" and the first mate "Mate." The radio officer is addressed, by one and all, officers and crewmen, as "Sparks." The boatswain —top sergeant of the deck gang—is "Bos'n," the pumpman is "Pumps."

Although the captain is absolute dictator, and his orders, under the law, must be obeyed, unreasonable orders can be protested very effectively after the ship reaches port. It is in fact the *duty* of the radio officer to note the fact in his log if he considers an order incorrect or dangerous. No captain is unreasonable. He would not sail as captain very long if he were. There is too much competition for that enviable job.

The radio officer's status as officer is a matter of law. On dry cargo freighters and tankers he has his own private cabin, usually located next to the radio shack. On the latest ships he even has

his own private bath; more normally, he shares the officers' facilities. His bunk is made up, and his cabin swept and dusted, by a utility member of the crew; and utility messmen also wait on him at table. Sleeping quarters are comfortable except that the bunk is only cot size; there are no bathtubs as a rule but showers are plentiful, with hot and cold running fresh water. Living and working quarters are always warm in winter (every ship's engine room produces heat in abundance). Quarters are not always cool in summer, although a very few of the newest ships are air-conditioned. Mostly, fans are used.

Food on freight ships and tankers commonly is good while in and just after leaving port. Fresh milk and leafy vegetables are not to be expected far out at sea. Because a ship's work runs through the 24 hours, coffee is available at any time and the messroom refrigerator usually contains the makings of a midnight snack—unless your fellow officers beat you to it.

There are no laundries on freight ships or tankers—officers and crew alike, even the captain, wash their own clothes. Clean towels and bed linen are furnished by the ship, but if the voyage proves unexpectedly long supplies may run out. In that case each officer can take his choice between washing his own or contenting himself with soiled linen.

Life on passenger ships is somewhat different. It is more formal: Shaving and uniforms may be required. The R.O.'s quarters and general comfort are much as described above. Meals, being on the passenger scale, are more elaborate. The late-evening snack may be served to the radio shack by a steward who brings a well-filled tray. Laundry facilities may be available. To what extent ship's officers, including the radio officer, are encouraged, permitted, or forbidden to mingle with passengers socially depends on company policy.

Beginners at sea often become seasick, but soon get their "sea legs" and aren't troubled any more. To the contrary, one comes to like the motion of a ship in fresh weather, and being rocked to sleep by it like a baby in a cradle. A violent storm is another matter. The seasoned seaman does not become sick, but the fierce rocking and pitching require a constant exertion of muscular force to maintain equilibrium, which soon becomes tiring. Not because there is any danger, but because of the discomfort, even the oldest and most experienced seaman is relieved when a storm subsides. As for danger—driving almost any highway on a Sunday afternoon is much more venturesome.

War risks are another matter. In World War II casualties in the merchant marine were higher than in some branches of the armed services.

Despite the fact that all ship personnel work a full 56-hour week at sea, all have plenty of spare time on their hands; the radio officer perhaps most of all. The time normally spent ashore in going places—commuting to work, or even traveling to amusement—is all saved. There's no place to go. "Commuting" to work is a matter of stepping across a threshold or down a corridor. Entertainment is found in listening to the short-wave radio, in playing cards, checkers, or other games, in reading, and in bull sessions. Sparks in particular has an abundance of spare time. Most of his work consists merely in listening to a loudspeaker and making a note of what he hears once every few minutes. He can keep his equipment clean and lubricated, make minor repairs, charge and care for the storage batteries, and do other chores, while simultaneously standing watch.

Sparks and the other officers soon become friendly enough for normal social intercourse aboard. One point of ship's etiquette that should be remembered especially: each man's work is his own business, and not open to comment by anyone except his superior.

The most important part of seafaring life is shore leave. Sparks is exceptionally fortunate in that respect because he has little to do when the ship is in port. He must wait aboard for quarantine and to draw his pay or part of it; he must wait or arrange to be back aboard if his equipment is to be inspected or supplies for it delivered; he must keep in touch by telephone often enough to make sure he won't be left behind if sailing orders are changed. Otherwise —unlike other officers, who have work to do in port—the radio operator is free to go ashore and stay as long as he likes.

The operator's wages

The operator's pay varies somewhat according to the ship. The chief radio officer of a large passenger ship may draw a base pay of $460 a month; but there is little overtime when the ship carries an around-the-clock supply of radio operators, as large passenger ships are required to do by law. Overtime may be paid, however, when the ship is at sea on Sundays or holidays—or if in port, if the radio officers are deprived of shore leave on such days.

The same Sunday and holiday overtime applies aboard freighters and tankers. Additionally, three hours overtime per week is often paid for charging the storage batteries, although it is entirely permissible to do this work while on regular watch. If Sparks is called on to work beyond his regular watches—to get storm warnings or radio-compass bearings, or for any other reason—overtime is paid for the extra hours.

On some freighters and tankers the ship's operator can earn up to roughly $100 a month additional by doing the ship's bookkeeping—making up the payroll, and the like—and by taking care of the "slop chest," which is the variety store that sells cigarettes, razor blades and other necessary items. (This "store" exists because the law requires it, and it must not earn a profit.)

The communications equipment

Communications and auxiliary equipment carried aboard is divided between the radio shack and the navigation room. The radio officer is completely and directly responsible for everything in the shack. His responsibility for the other electronic installations is much lighter.

The shack commonly is fitted with two transmitters and two receivers, plus the auto alarm. The latter is the automatic receiver and keyer for distress signals. Also often kept in the shack is the portable lifeboat radio, which Sparks tests from time to time to keep it always ready for emergency, and which he carries to his assigned lifeboat in case of "abandon ship."

The standard international marine communications frequency is 500 kc. This is the distress call frequency. It is also used for general calling, but not for traffic. When contact has been established or is expected as a result of a call broadcast on 500, the caller designates some adjacent frequency between 500 and 100 kc for working. Thus 500 is kept open for distress calls.

The ship's main transmitter is tuned to 500 and to a number of other frequencies. The main receiver has a range from 500 kc downward to perhaps 16 kc or thereabouts.

Additionally, most ships carry a high-frequency transmitter capable of operating on the assigned marine bands up to perhaps 25 mc, and a short-wave receiver with a continuous tuning range from roughly 2000 kc to 25 mc.

The auto-alarm is a receiver tuned to 500 kc and equipped with step-by-step audio selection to respond to the automatic distress call only. That call is not the conventional SOS (. . . — — — . . .) but instead a series of 12 dashes, each exactly 4 seconds long and spaced by intervals of exactly one second.

The operator's duties

All this equipment is the responsibility of the radio officer. He not only operates it; he keeps it in condition and repairs it when it goes wrong. Extensive repairs are not expected of him; he is primarily an operator and not a repair man. Nevertheless, it is his job and responsibility to maintain communications, and with two receivers and two transmitters he should be able to do it.

Routine operation of the shack equipment divides into listening and transmitting. Primarily Sparks listen to ("guards") 500 kc. He listens for three things: distress calls, calls for his own ship, and general traffic notices that may or may not concern his ship. When the latter require him to shift to another band for further details, he may abandon 500 kc temporarily.

Since ship's business of various kinds —including navigation warnings, storm warnings, and calls for the ship itself—may also come over h.f., it is common practice to keep two loudspeakers on and guard an appropriate h.f. band in addition to 500. Keeping that kind of watch does not preclude other activities. Sparks on watch is in the position of a

person eating lunch in a crowded restaurant with much conversation all around. He can attend to his lunch and ignore the conversation with complete assurance that if his own name is called or something of special interest to him is mentioned he will certainly hear it. Similarly, Sparks can do the ship's bookkeeping while on watch, or write letters, or dress the storage batteries, with two loudspeakers running and absolute confidence that if anything comes through either that concerns him, he won't miss it.

Ship's business to be received includes direct instructions—for example, orders for change in destination, or docking instructions on approaching port. Indirect business includes storm and navigation warnings, weather forecasts and time signals. The latter are needed by the navigation officers for check on the ship's chronometers.

Business to be transmitted includes the daily position report—the owners want to know where the ship is and what progress it is making. A brief coded weather report also may be sent. On approaching port the captain will want to send a message containing expected time of arrival, and need for fuel or supplies, if any. Bearings and position reports may be requested from shore stations rendering such service. On passenger ships, passenger radiograms may keep the radio operators busy and the transmitters hot.

Miscellaneous equipment

The auxiliary equipment found in the navigation room now almost universally includes a direction finder. This is a receiver with a well-designed rotatable loop antenna, through which the ship takes its own bearings on shore stations and, by triangulation on two stations, may find its own latitude and longitude. Sonar is an audio-signal transmitter and receiver through which a pulse of sound is transmitted to the bottom of the sea and the echo caught and timed. A dial calibrated to the velocity of sound in salt water reads the depth directly in feet or fathoms. "Iron mike" is a gyroscopic servomechanism that operates the steering wheel, replacing the helmsman and keeping the ship on any course desired.

All these auxiliaries are commonly operated by the navigation officers. When one breaks down, however, Sparks may (or may not) be asked to make repairs, at overtime rates. It is permissible but not wise to plead ignorance of the equipment. Sparks will do better, if the captain is willing, to borrow the instruction books for those items of electronic equipment and read up on them in advance. Both his income, and the respect accorded him aboard, will be enhanced. The same applies to radar equipment.

Whatever the radio officer does in the line of duty, he notes in his log. If he merely listens and hears nothing of interest, he enters one call heard each 15 minutes, to show he was on watch.

This installation is in the radio room of the Moore-McCormack liner *Uruguay*.

The technical requirements

Examinations for technical competence are given by the FCC. They relate to standard electronic principles and practices with which the trained radioman is familiar. He may need to brief himself a little on the detailed applications of those principles to ship's equipment.

Those imperfectly familiar with the International Morse code will find that more of a stumbling block. No one has ever invented a way to learn Morse except by practice. To receive well, it is necessary to persevere until the beginner's habit of translating Morse into English to understand it has been overcome.

To send well, it is necessary to persevere until wrist and fingers form perfect characters mechanically without any attention—a muscular habit perfected and automatic. Sending and receiving speeds of 25 words per minute are required for a first-class license. It is not necessary to receive on a typewriter. A pencil will do, for service on freighters or tankers. Typing is necessary on passenger ships where traffic is heavy, and messages must be taken down right the first time because there is no leisure to retype.

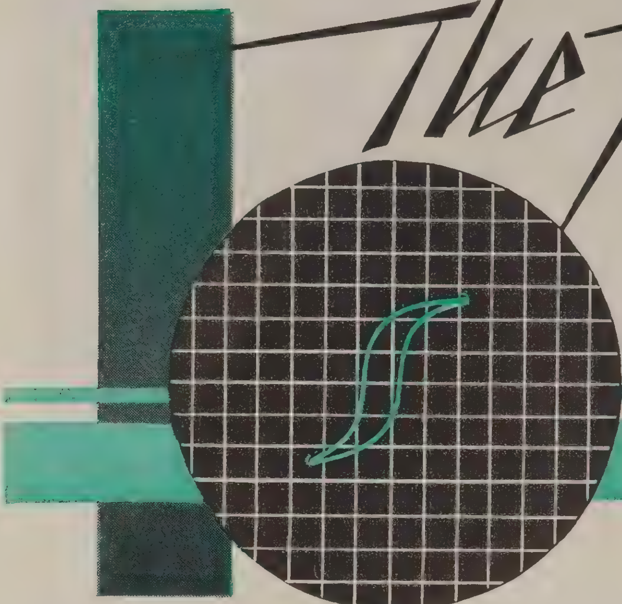
The Coast Guard examines license candidates for loyalty and for knowledge of first aid. The latter is required because freighters and tankers do not carry doctors. All officers must know how to give first aid in illness as well as accident. A radio service exists by which Sparks can get medical advice through a shore station.

The FCC license certifies that the holder is a competent operator; the Coast Guard license makes the holder a merchant marine officer under the laws of the United States.

The radio officer's status, duties, and privileges aboard ship are thus affirmed and defined by law, as well as by the customs of the trade, and by labor unions. There are several unions. Membership is wide open now that the demand for radio officers has again become strong. It is not necessary to be a member of any union, although most ship companies are now organized under contract. Unions have done an enormous amount of good work for the radio officer during the past 20 years. Twenty years ago the pay was not one-tenth what it is now; privileges and living accommodations were poorer; and the "wireless operator" did not have legal status as a ship's officer.

The law is singularly favorable toward the radio officer who wants to make a lifetime career of his work. Other technicians may be displaced by technological improvements. But the law says that ships MUST use Morse communicating equipment, and MUST carry Morse-trained men to operate it. International treaties so require. Those treaties, since they have been duly ratified by the U. S. Senate, carry in this country not merely the force of law but that of amendments to the Constitution. They are not likely to be altered to permit elimination of the radio officer in favor of mechanical devices until the poorest and most backward seafaring nations agree.

The R.O. who wishes to convert the present temporary opportunity for service at sea into a lifelong career can do so quite readily. Now that radio officers are scarce, it is quite practicable to get into the service of one of the steamship companies that have rules of seniority, pension and vacation plans, and similar up-to-date employee benefits and relations. But the R.O. who is willing to settle down to the area covered by a single company of the type just referred to, and who joins such an organization and accumulates seniority, can have a well-paid and protected career at sea. —end—



The Magnetic AMPLIFIER

By A. A. BOSSCHART

Rugged unit uses d.c. to control power; gain to 10 million possible

MAGNETIC amplifiers have been used for many years. As early as 1916, Alexanderson of G-E used them to modulate a 72-kw transatlantic radio transmitter. Many countries have contributed to our present-day knowledge. The German navy, after experiments, used them to stabilize range finders during the last war. Dr. Uno Lamm of Sweden is the author of one of the best works (*Fundamentals of Transductors or Magnetic Amplifiers*) available on the subject. Japanese scientists conducted research on core materials for many years and developed several excellent high-permeability types.

Magnetic amplifiers are sometimes called d.c. transformers, an appropriate name. They consist essentially of a magnetic core and coils of wire. One or more *input* coils are fed with d.c. to control the power available from the *output* coils. Power is taken from the line or other source of a.c. The a.c. power supply is 60–1,000 cycles.

Unlike a tube amplifier, the magnetic type has relatively high distortion and an inherent time delay as great as 0.1 second. It is not applicable to many types of amplification, and would not be found in a phonograph amplifier.

However, it is far more rugged than a tube amplifier, requires no filament supply, and needs no maintenance, so it is ideal for many industrial applications. It is especially suitable for amplifying d.c. signals, which fluctuate very slowly; therefore it is well adapted for use with thermocouples and photocells when they are used for such purposes as turning on lamps at dusk or recording slow changes of temperature. The magnetic amplifier is also widely used in servomechanism applications.

Magnetism

Magnetic theory and electric circuit theory are very similar. Ohm's law may be written: $E = IR = I/G$, where the conductance G equals I/R. In a magnetic circuit $MMF = \phi/P$. In this equation, MMF is the total *magnetomotive* force in the circuit. It corresponds to EMF and can be stated in ampere-turns (NI). Total *flux* ϕ corresponds to current and total permeance P is similar to conductance in an electric circuit. Permeability μ is related to permeance P as resistance is to specific resistivity, and might be called the specific permeance of a material. For example, the permeance of a piece of material varies with the size of the material, just as the resistance of a wire varies with the size and length of the wire. The resistivity remains the same (10.36 ohms per mil-foot for ordinary copper wire). However, the permeability of a magnetic material may change with the magnetomotive force applied to it (as the conductivity of a metal rectifier may change with the density of current). This makes magnetic circuits much harder to calculate than electric circuits.

Magnetic circuits are analyzed by considering the length and area of the path. Instead of total MMF we use the *field intensity*, or H, which equals the MMF divided by the path length.

In the same way, *flux density*, or B, is considered instead of total flux. If B is constant over an area A, $\phi = BA$. Permeability is equal to B/H, or $H\mu = B$. This means that in materials with a high μ, only a small magnetizing force is necessary to have a high flux density. The permeability of air is set at 1, and various types of iron and magnetic alloys may have a permeability of about 600 (cast iron) to 50,000 or more (permalloy and other special magnetic alloys).

The *self-inductance* L of our magnet coils is also important in magnetic amplifier theory. If an alternating current is applied across a coil, B varies at the same rate as the alternating current. This variation in the magnetic field induces a counterelectromotive force in

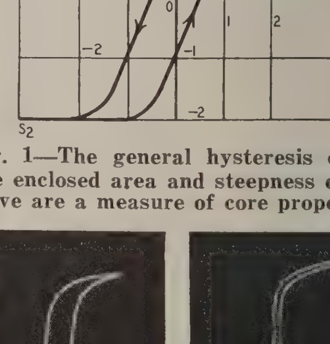


Fig. 1—The general hysteresis curve. The enclosed area and steepness of the curve are a measure of core properties.

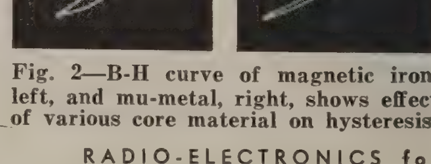


Fig. 2—B-H curve of magnetic iron, left, and mu-metal, right, shows effect of various core material on hysteresis.

the coil which is proportional to the flux density B and the frequency f. Two important facts should be remembered: the induced voltage E is proportional to B and f; and, field intensity H is proportional to current I.

Magnetization curves

From the foregoing, it appears that we can increase the flux density B by increasing the magnetizing force H. Since $H = NI$, it would appear that increasing the current or the number of turns around a core increases B. When a.c. is applied to a winding, though, we come up against *hysteresis*, or magnetic friction.

Magnetic material is supposed to be composed of small permanent magnets, which in an unmagnetized piece of material are randomly oriented—that is, they point in all directions. Passing an electric current through a coil wound around the material magnetizes it—aligns the magnets so they all point in one direction. But if the current is turned off the material does not go back to its unmagnetized state. Many of the minute permanent magnets remain lined up and give the material more or less *residual magnetism*. It is necessary to pass current through the coil in the opposite direction to *demagnetize* the material. This is shown in Fig. 1.

The magnitude of H plotted along the horizontal axis represents current through the winding, since $H = NI$; the vertical axis represents flux density B. If alternating current is applied, during the starting half cycle (represented by the line inside the closed curve), B increases as current is increased. As the current reaches 1.5 on the chart (divided into arbitrary units) B reaches its maximum and remains the same even though H passes 2. S_1 and S_2 are saturation levels.

As the current is *reduced* toward zero, magnetic flux density in the core remains at maximum till the coil current has dropped below 1, and then drops slowly, so that B is still nearly 1 when the current is zero. To demagnetize the core (reduce B to zero) it is necessary to apply a current of about

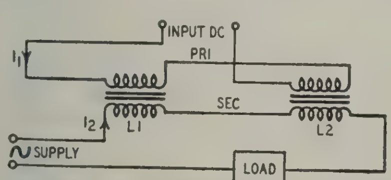


Fig. 3—Simple circuit of the amplifier.

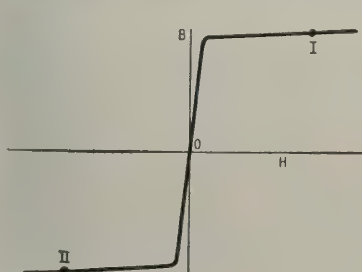


Fig. 4—The amplifier operating curve.

–0.4. After this point, the core magnetizes in the opposite direction, so that when current reaches –1, the core is again magnetized to *saturation*.

From here on each alternation produces the same result, magnetism always lagging behind magnetizing force till the core is saturated, then remaining constant through any increase in H. A certain amount of power is used to turn the molecular-sized magnets around in the material. This is called *hysteresis* loss.

The enclosed area and width of the curves in Figs. 1 and 2 are a measure of the hysteresis, or magnetic friction, of the material. The best material for magnetic amplifiers is the one with the narrowest curve. Note, Fig 1, if the material were perfect, the curve which started from zero and went up to 2 as H increased would decrease in exactly the same fashion. That is, by the time the coil current (NI) which produced H had sunk to zero, the magnetism B would be at zero also. Then the B-H curve would be a slim line. But, the higher on B the curve is when H reaches zero, the stronger the negative H field (current in the coil in the opposite direction) will have to be before B goes to zero; the field will have to be stronger after the current in the coil has turned again, to bring B back to zero. This widens the curve.

It is impossible to get a single-line B-H curve (perfect magnetic material) but narrow curves can be obtained with magnetic alloys, as may be seen in Fig. 2.

Modern magnetic material has low hysteresis losses, so the two branches of the curve are close together. Fig. 2 shows B-H curves for magnetic iron and high-grade magnetic alloy. In transformer design the working point is along the linear portion of the B-H curve. The area of saturation is used for magnetim amplifiers and is different for different core materials.

Magnetic amplifiers

A circuit for the simplest type of magnetic amplifier is shown in Fig. 3. The secondary coils L1 and L2 are connected in series-aiding. The equal primaries are connected in opposition. A source of alternating current is connected in series with the secondary and the resistive load. The cores, of high-permeability alloy, increase the self-inductance of L1 and L2 to such a high value that little a.c. can flow through them and the load. But if d.c. is passed through the primary and increased till the core saturates, its permeability drops, the secondary self-inductance becomes negligible, and a.c.—limited only by the resistance of the load—flows. If the amount of d.c. is kept slightly below the saturation point, small changes in the d.c. can produce large changes in the a.c. through the load. Thus *the d.c. input controls the current through the load.*

If the current in the primary is I_1 and that in the secondary, I_2, then the a.c. component in the secondary is

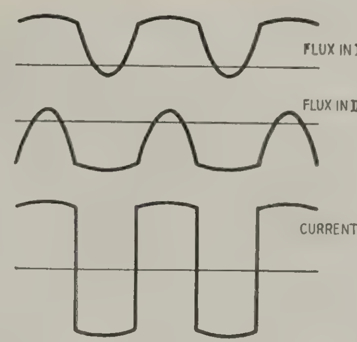


Fig. 5—Flux waveforms in core.

$(I_2 + I_1)$ and the a.c. component in the primary is $I_2 - I_1$. If curves (not shown) drawn for both these conditions are *added*, the waveshape current in the secondary is $(I_2 + I_1) + (I_2 - I_1) = 2I_2$; the primary wave shape resulting from *subtracting* one curve from the other (the primaries are series opposing), $(I_2 + I_1) - (I_2 - I_1) = 2I_1$ and the waveshape in the primary will have an a.c. component *twice* the supply frequency.

Fig. 4 is the operating curve of a magnetic amplifier. If heavy d.c. is applied to the primaries of Fig. 3, the two cores will be oppositely saturated, because the d.c. flows in opposite directions through the two cores. With no a.c., the operating points are at I and II of Fig. 4.

If a.c. is switched on, it magnetizes each core *in the same direction.* During the first or positive half cycle the current acts to increase the magnetization of the already saturated core L1 as indicated at I, so there is no effect. But it acts to neutralize the magnetization L2, as indicated at II in Fig. 4 (imagine the operating point moving to the right), and if the current is great enough, the flux will drop to zero. During the second half cycle the flux in L1 drops to zero and L2 is unaffected (operating point moves to the left). The flux waveforms in each core and resulting output current are shown in Fig. 5.

It is then apparent that for *large power output* the hysteresis curve should be long. For *high amplification* a steep curve (indicating high μ) is more desirable, since a slight change in d.c. causes a large change in the magnetization of the core, and thereby has a greater effect on the a.c. output current.

It is not necessary that a magnetic amplifier have two coils in the primary and the secondary, or that they be in series. It is possible and often desirable to connect the coils in parallel. We may also use more than one coil in the input circuit, to amplify more than one input voltage, or even to amplify the resultant of the input voltages, a thing which usually presents difficulties when attempted with vacuum-tube amplifiers. It is also possible to construct a magnetic amplifier with only one winding for the d.c. coil, so placing the coil that its field affects both a.c. coils in the right way.

A shell-type transformer (Fig. 6) can be used to cancel a.c. from the primary. The center leg is used for the d.c. coil, while the outer legs hold the output

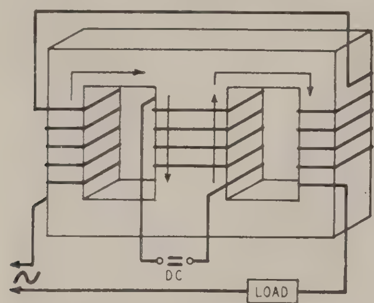


Fig. 6—Magnetic amplifier on shell-type frame uses one primary winding.

a.c. windings, which are oppositely wound. The arrows show how induced voltages balance out in the d.c. winding.

When a.c. flows through the output circuit of an amplifier, one half of each cycle tends to desaturate the core. This can be prevented by adding a rectifier (with proper polarity) in the secondary. Such an amplifier is called a *self-saturating* device. The *rectified* d.c. now adds to the *control* d.c. to give increased amplification. If too much feedback is used, the amplifier may go into sustained oscillation.

Fig. 7 shows how a self-saturating amplifier is connected. The a.c. source is connected in series with L3 and a full-wave rectifier. Rectified current flows through the load and L2. The d.c. through L2 combines with the d.c. in L1 to control the amplifier.

One big disadvantage of magnetic amplifiers is *time lag*. Typical circuits have a delay of 6 cycles with a 60-cycle supply frequency, and 16 cycles with a supply frequency of 333. Note that the proportional lag is reduced as the sup-

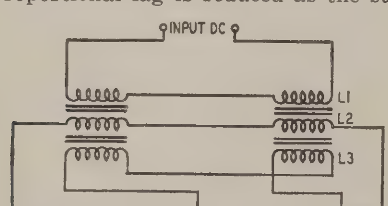


Fig. 7—A self-saturating amplifier.

ply frequency is raised. Special "phase advance" circuits have been developed to minimize the effects of time lag.

Applications

Modern magnetic amplifiers can be designed with a power gain as high as 10 million, while a gain of 10,000 is a very practical figure. Signal inputs may be as low as .001 microwatt. Unlike a tube amplifier, the magnetic type is current-operated. Therefore the input resistance is low. However, less distortion is produced if the input resistance is kept as high as possible.

Fig. 8 is a typical frequency stabilizer. Here a 2-phase motor drives a 3-phase generator. There are three d.c. control windings in the amplifier, L3, L4, and L6. The first and third of these are control windings wound in the same direction. L5 is the a.c. or secondary coil. The required generator frequency is assumed to be 500 cycles. Two series-resonant circuits (L1 and L2) are across two phases of the generator. One is tuned to 475 cycles—the other to 525 cycles. If the frequency is too high (above 500) more current flows through L2 and less through L1. After rectification, there is more d.c. through L3 and less through L4. These are so poled that in this case more a.c. flows through the output winding L5. Therefore more

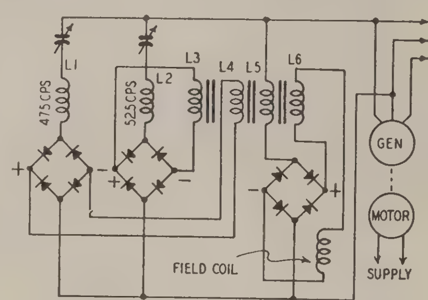


Fig. 8—A typical frequency stabilizer.

d.c. flows through the feedback coil L6 and through the motor field coil. This slows the motor and reduces the generator frequency. Accurate stabilization to within 1 part in 1,000 is possible.

Another useful application is for measurement of current in high-voltage d.c. lines. Two toroidal cores with windings are placed around the line (Fig. 9) and a.c. is fed to the coils. The d.c. saturates these cores to a greater or less degree (depending on the amount of d.c.). A small a.c. voltmeter may be calibrated to read the direct current.

The reader may realize by now that the design of a magnetic amplifier is involved. For example, there is no simple relationship that expresses the power output available. Various factors such as linearity, input and output resistance, etc., complicate the problem. The factor of interaction between the output and input circuit (the a.c. in the output induces currents in the input) has been merely skirted in this article. Still other problems have not been mentioned.

For these and other reasons magnetic

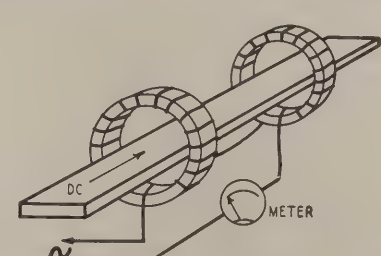


Fig. 9—Measuring current in d.c. lines.

amplifiers have not become as widely known as they otherwise might have. A possibly more important reason is that they are not too adaptable to experiment by the individual enthusiast. Suitable core materials, such as the expensive permalloy and mu-metal, are hard to obtain. Generally speaking, most ordinary core material is not easily enough saturated to use as magnetic amplifier cores, though it is possible that some results might be obtained.

The would-be experimenter can obtain B-H curves directly with an oscilloscope with the circuit of Fig. 10. The core material being investigated is placed within a coil L through which a.c. flows. A relatively small resistor (470 ohms) is connected in series with L. The drop across this resistor is proportional to the current through L and therefore to the field intensity H. This drop produces horizontal deflection. The induced voltage across L is integrated by an R-C network as shown and applied to the vertical plates. It can be shown mathematically that the integral of the voltage is proportional to the flux. Therefore the vertical plates are supplied with voltage which varies as B.

Only materials with a small hysteresis area (highly permeable) should be used. A steep curve indicates high permeability, and likewise great amplifica-

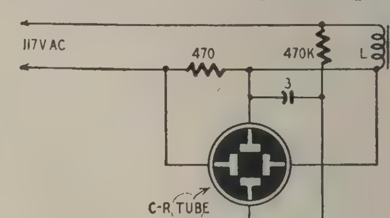


Fig. 10—Circuit to read BH on scope.

tion. Materials with a high value of saturation are good for power applications. The following bibliography will aid the student who wishes to pursue the subject further. He will find the calculations of A. G. Milnes and Dr. Uno Lamm particularly interesting if he wishes to enter the design field.

References

The Transductor; D.c. Pre-saturated Reactor. Uno Lamm, Stockholm, 1948.

A New Theory of the Magnetic Amplifier. A. G. Milnes, *Proc. IEE*, Aug., 1950. Part II.

The Transductor Amplifier. Ulrich Krabbe.

Rectifier Voltage Control. *Wireless World*, June, 1949.

Amplification by Magnetization. *Westinghouse Engineer*, May, 1949.

Magnetic Amplifiers. *Wireless World*, Feb., 1949.

Applications of Magnetic Amplifiers. *Electronics*, Sept., 1947.

Components of U. H. F. Meters. Eduard Karplus, *Electronics*, 1946. *Frequency Modulation by Nonlinear Coils*, L. R. Wrathall, *Electronics*, May, 1946.

Ibid. *Bell Laboratories Record*, March, 1946.

Reactance Amplifiers. *Electronics*, Oct., 1947.

Voltage Rectifiers Using Magnetic Saturation. *Electronics*, July, 1937.

Selbsttagtige Strom and Spannungsregler. *Achiv fur technische Messen*, Nov.-Dec., 1934.

(In editing Mr. Bosschart's excellent and in some parts very technical manuscript, it was necessary to abridge some points and omit others. Our apologies to Mr. Bosschart if he feels that we have oversimplified his exposition in parts. We believe that the changes were necessary to make this difficult subject intelligible to persons with no previous knowledge of magnetic amplifiers.)

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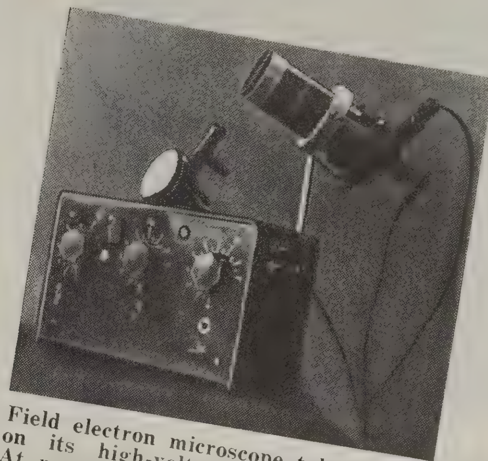
The Practical Field Electron Microscope

Simple instrument magnifies million times with 20 Å resolution; only 5 kv is needed

By DR. ERWIN W. MÜLLER*



Field electron microscope tube resting on its high-voltage supply cabinet. At rear is a projection viewing unit.

FOR over-all effectiveness, the magnification of a microscope is less important than its resolving power. The resolving power determines the smallest separation between two points at which they can still be distinguished. This resolving power, under the most favorable conditions (that is, using widely divergent beams) amounts to a half wavelength of the light used. Points just 2,000 Ångströms apart may be resolved with an ordinary light microscope. The great effectiveness of the well-known electron microscope depends upon the very short electron wavelength which, at a 100 kv beam voltage amounts to about .04 Angstrom. Because of the large optical defects of electron lenses, it is necessary to use them with very small apertures, and a resolving power of only 15-20 Ångströms is attainable. Nevertheless details 100 times finer than those recognizable with the light microscope may be resolved.

To recognize fine objects it is further necessary to have sufficient contrast. This is difficult with the electron microscope because of the necessity of working with very thin layers. These thin layers are transparent for the fast electron beams. Theoretically (for example) 500 carbon atoms must be agglomerated to form an image point with 1% contrast. Indeed, the finest objects that have been made visible by the electron microscope are macromolecules with a molecular weight of more than 100,000.

The contrast in the emission microscope, from which the whole development of the electron microscope stemmed, is more favorable. Even a monoatomic layer is sufficient to influence the electron productivity of the cathode surface which forms the image. Unfortunately, the resolving power is very small because the electrons start from the surface with a velocity corresponding to a few tenths of a volt, and consequently a large wavelength. The electrons should be accelerated very rapidly near the cathode; but in order to achieve the resolving power of the modern transmission electron microscope, a field strength of 10 million volts/cm is needed at the cathode. Electron lenses cannot be constructed for such extremely high field strengths.

Field electron microscope

The necessary magnification for the observation of the smallest objects as well as the electrical field strengths for achieving the high resolving power may be obtained in a surprisingly simple manner without any electron-optic lenses. This is accomplished with the field electron microscope invented by the author 15 years ago, although the full effectiveness of the instrument has only recently been demonstrated.

The field electron microscope consists of an evacuated tube in which a fine metal point stands opposite a screen (Fig. 1). The metal tip is cap-shaped, almost hemispherical, perfectly smooth, and has a radius of 10^{-5} cm. If 5,000 volts are applied to the anode ring, a field strength of about 40 million volts/cm results. Under these conditions field electrons are emitted from the tip. They flow radially from the tip in straight lines to the screen and form a projection image of the tip. The enlargement is simply the ratio of screen distance to tip radius. A millionfold magnification results with a screen distance of 10 cm.

The electrons emitted from a point object have a small tangential velocity component of about 0.5 electron-volts so that the image on the screen is a disc of about 2 mm diameter. This corresponds—at a magnification of 1,000,000—to an object diameter of 20 Ångströms. The resolving power attainable with this simple microscope, of about

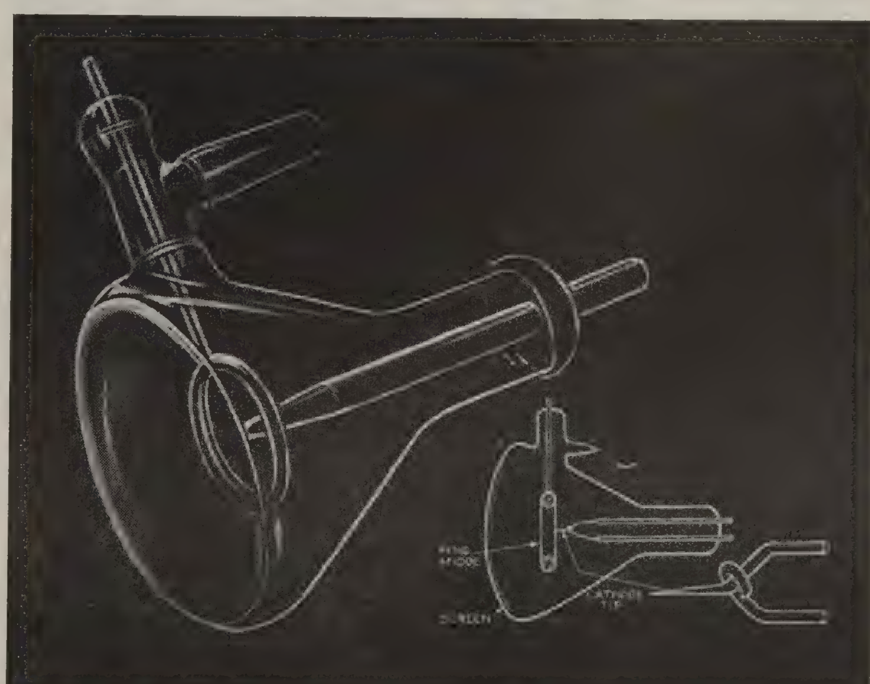


Fig. 1—The principle of the field electron microscope is very simple.

*Kaiser-Wilhelm-Institut für Physikalische Chemie und Elektrochemie, Berlin Dahlem, Germany.

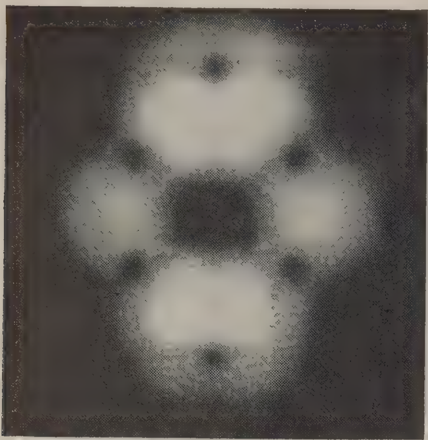


Fig. 2—Image of a clear tungsten tip.

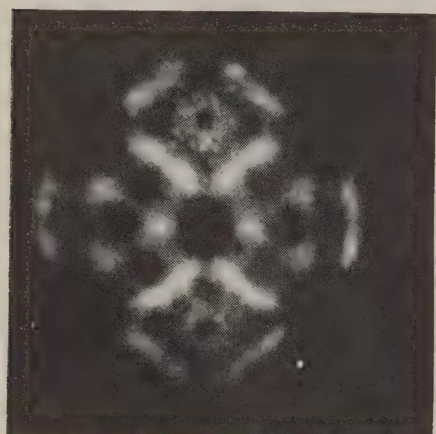


Fig. 3—Thin film of single barium atoms adsorbed on a tungsten tip.

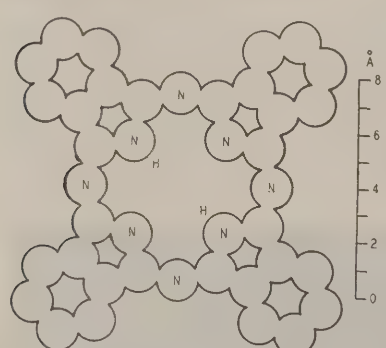


Fig. 4—Ideal theoretical diagram of a single molecule of phthalocyanine.

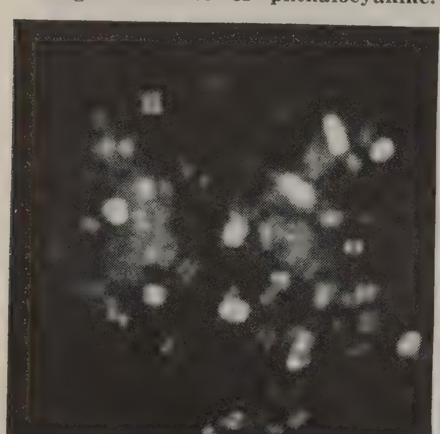


Fig. 5—The four-sectioned molecules of phthalocyanine are visible above.

15 Angströms, is not inferior to that of the usual electron microscope.

The objects suitable for examination with the field electron microscope are entirely different than for the standard microscope. The pure cathode surface gives a picture of the crystal structure of the metal of the tip. In Fig. 2 the particular crystal directions of tungsten are recognized because the 110 and 112 surfaces are characterized by low electron emission. The fine lattice steps, only about 3 Angströms, from which the whole crystalline cathode tip is built, cannot be seen with the given resolving power.

The object to be observed must be placed on the tip by sublimation or adsorption. Many gases are adsorbed on specific crystal surfaces so that their presence may be established in quantities corresponding to less than monoatomic thickness. Indeed, it is possible to observe reactions between different adsorbed substances in which the metal of the tip acts as a catalyst. The temperature range over which observations may be made is wide. The whole tube may be immersed in liquid air so that adsorption processes at –180°C may be observed, since the tip does not become heated by the emission. At the other extreme, contact catalytic processes that occur at red heat may just as easily be observed.

Single large atoms are individually recognizable if they are adsorbed on the very smooth and perfectly round tip in favorable orientations. Fig. 3 shows a very thin adsorption film of barium in which the granulation arises from single barium atoms.

The average distance of separation of the atoms in the less densely filled region about the cube faces (top and bottom center Fig. 3) amounts to about 30 Angstroms to 40 Angstroms, in the more densely filled regions to about 20 Angstroms. The field emission is completely independent of the temperature, and if the cathode is heated somewhat the surface migration of the adsorbed atoms can be seen. This occurs at different rates, depending on the adsorption energy on the various crystal surfaces.

These migrations can even be followed quantitatively. With tungsten atoms sublimed on the tip, the measurement of the energy of activation of the surface migration gave precisely the theoretical value calculated for single atoms. This constitutes important evidence that the smallest visible image points correspond not to an agglomeration of a large number of particles, but rather to individual atoms.

The visibility of certain types of small articles can be demonstrated easily with some organic molecules. If the dyestuff phthalocyanine, whose molecular structure (Fig. 4) is known exactly as a result of chemical analysis and long calculations, is sublimed onto the tip, the contour of the flat molecule is made clearly visible (Fig. 5). Because of the thermal motion and the impact of positive ions, a rotatory motion of the four-sectioned molecule can often be seen.

Resolution of the molecular image in a four-sectioned form similar to the object results from the molecules being adsorbed flat on underlying impurity atoms. These impurity atoms are easily adsorbed on the crystalline surface of the tip. The potential distribution directly in front of the molecule causes a divergence of the electron beams leaving the four corners. In this special case, a resolving power of 7.7 Angstroms, the average distance between the corners, consisting of benzol rings, is attained. Each of the four corners of the molecule has a weight of 128 and is just about as heavy and as large as a single barium atom with an atomic weight of 137 and a diameter of 4.5 Angstroms.

Even the essentially smaller porphyrin rings of haemine or chlorophyll with their four-sectioned structure are made visible with the field electron microscope. The distance of the pyrrol ring corners amounts to only five Angströms. This is the smallest separation of two particles resolvable with an electron microscope to the present time. It is not to be expected, however, that the location of single atoms can be determined with the simple field electron microscope. [From rubrene, for example, four-sectioned images with only one symmetrical axis are obtained. The two ends of the molecule containing a middle tetracene nucleus differ in the direction of the region corresponding to the four-sided phenyl residues.] Only as many singularities are seen as a result of diffraction effects in these kinds of molecules as is recognizable in the profile of the equipotential surfaces about 12 to 15 Angströms above the adsorbed molecules on the cathode. It is only at this distance from the cathode that the electrons concerned have a short enough wavelength to achieve a resolving power of 5 A.

Even here (as generally in microscopy) the wavelength of the applied radiation imposes on the effectiveness a limit that can hardly be overcome. The true form of the molecules can be established in only a few favorable cases. The field electron microscope affords for the first time, however, a general method of viewing such small objects directly. The instrument's most important region of applicability may be the investigation of the behavior of adsorption films on metal crystals rather than making visible individual atoms. All processes of surface reactions and contact catalysis proceed in similar adsorption layers. These can now be extensively observed. Obviously the technique of observation as well as the interpretation of the pictures obtained requires laborious investigation and much experience.

References

E. W. Müller, *Z. f. Physik*, 106 (1937) p. 541, 108 (1938) p. 668, 120 (1943) p. 270, 126 (1949) p. 642. *Z. f. Naturforschung*, 5a (1950) p. 473.

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How an Electronic Brain Works

Part XII—Pulse patterns rearranged and programmed

BY EDMUND C. BERKELEY and ROBERT A. JENSEN

IN THE last few articles, we have shown how an electronic brain can store information, add, subtract, multiply, divide, and arrange different timing pulses and select them. We have also shown how, when the right control pulses are provided, an electric brain can pick numbers out of storage, run them into the computer, produce computed results, and put the results back in storage.

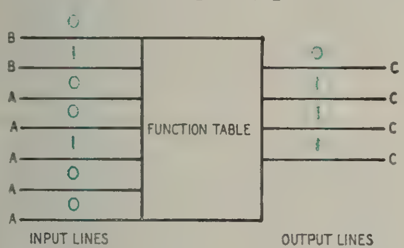

Fig. 1—The function table converts incoming pulses into other pulse patterns.

In this article we shall finish with such of the theory of electronic computer construction as we intend to cover.

We must emphasize again that not all the work in the design of a miniature electronic brain has been done yet, not by a long way. For example, one of the elements that will turn up in such a computer over and over again is the AND circuit; there are many different ways of making one; energy spent on perfecting an AND circuit useful for all parts of the machine would be well repaid; but we shall not investigate that subject here. Furthermore, the authors have as yet constructed only a miniature relay Simon, not a miniature electronic Simon; no one has yet made a miniature automatic electronic sequence-controlled digital computer (to give it its full name).

It is interesting to note one reader of RADIO-ELECTRONICS, Thomas P. Weir, W7GDM, of Powell, Wyoming, has written us that he has started construction of "a small machine using tape and a pulse frequency of 60 cycles"; and it may well be that one of the readers of RADIO-ELECTRONICS will be the first man to make a miniature automatic electronic computer.

Function tables

The term *function table* means an arrangement of equipment which will take in any one of a number of patterns of pulses and will put out any one of a number of other patterns of pulses, in such a way that any outgoing pattern is precisely determined by the incoming pattern. See the block diagram in Fig. 1, where the pattern 0100100 on seven input lines is being converted into the pattern 0111 on four output lines. Other names for function-table are *matrix*, *coding device*, *coder*, or *decoder*.

In an electronic computer, function tables may be used in many different ways, in fact wherever a mathematical function of pulses is desired. Examples are: 1—a built-in multiplication table; 2—conversion of binary digits to decimal digits, or of decimal to binary; 3—built-in tables of first approximations to reciprocals, so that hardware for dividing can be left out and the accurate reciprocals can be calculated by successive multiplications (see article X of this series); 4—built-in tables for first approximations to square roots, logarithms, etc., with the same kind of scheme for successive approximation;

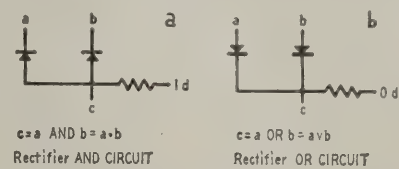

Fig. 2—Function tables use rectifiers.

5—conversions of orders (i.e., one kind of a set of pulses) given to the computer into control signals (i.e., another kind of a set of pulses) for gates (AND circuits), so that the machine can be automatically controlled.

One of the most convenient elements to use in a function table is a crystal

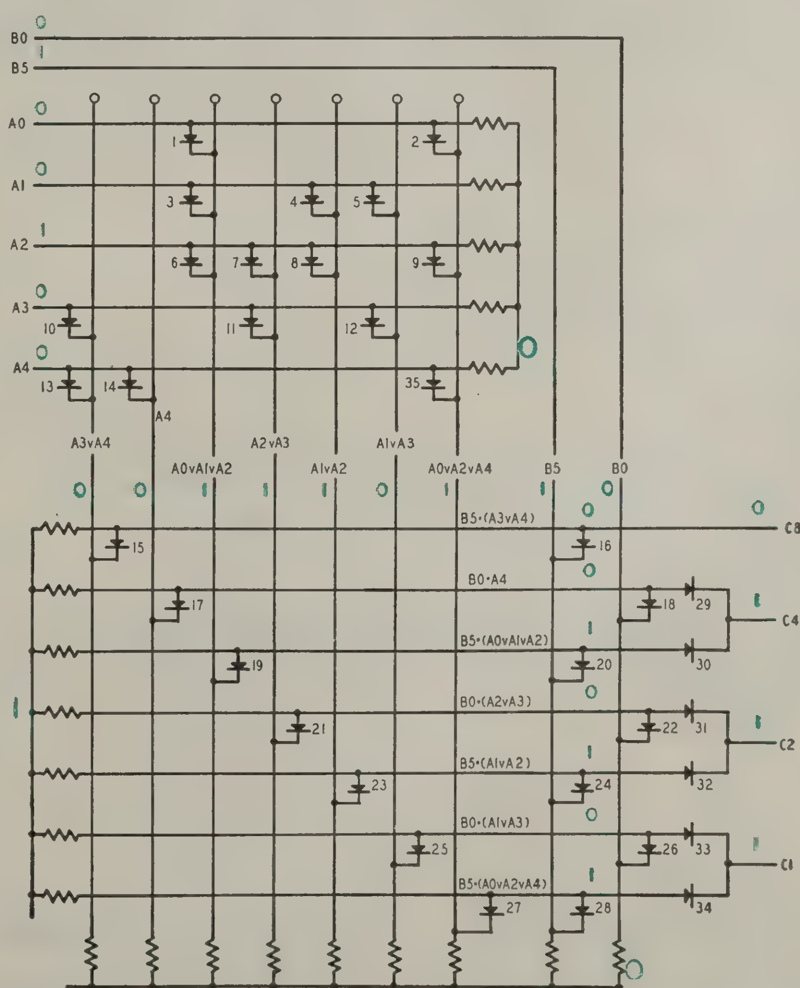

Fig. 3—A complete function table for converting biquinary notation to binary.

diode, or rectifier, although other elements may be used. The computing unit of SEAC consists entirely of rectifiers; the few tubes in use in that unit are for amplification only, do not compute, do not change pulses into other patterns.

How do we make use of rectifiers for a function table, for transforming one set of pulses into another set of pulses, such as the case shown in Fig. 1 of the three logical circuit elements, an AND circuit, an OR circuit, and an EXCEPT circuit, the first two can be constructed readily with rectifiers, and the third can be constructed if the negative of a pulse is available. Suppose that we have two voltages, which will be designated 1 for the higher voltage and 0 for the lower voltage. Then an AND circuit is shown Fig. 2-a, an OR circuit Fig. 2-b.

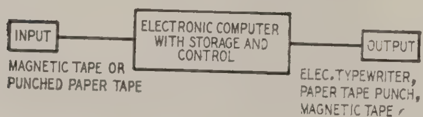

Fig. 4—Computer input and output.

In each of these circuits, there are four terminals. A common point in the circuit is connected across a resistance to terminal d, which in the AND circuit is kept uniformly at voltage 1, and in the OR circuit at voltage 0. Terminals a and b are input and c is output.

Now what happens? Examination of the AND circuit shows that the voltage at c will be 1 if and only if the voltage at a is 1 AND the voltage at b is 1. Also, in the OR circuit the voltage at c will be 1 if and only if either a or b or both a and b have the voltage 1. Hence, these circuits are properly AND circuits and OR circuits.

Using a rectifier there is no way of converting a pulse into its negative. But if the negative of a pulse is available—from a tube or otherwise—the AND circuit can be an EXCEPT circuit, simply by putting the negative pulse on one of the input lines.

Coding conversion

One of the ways function tables can be used is for converting a decimal digit expressed in one kind of notation into a decimal digit expressed in another kind of notation. This is useful to do from time to time in an electronic computer because some kinds of operations are much easier in some notations than in others.

For example, one of the ways in which decimal digits can be represented is the following regular notation:

Decimal	Binary 8	4	2	1	Decimal	Binary 8	4	2	1
0	0	0	0	0	5	0	1	0	1
1	0	0	0	1	6	0	1	1	0
2	0	0	1	0	7	0	1	1	1
3	0	0	1	1	8	1	0	0	0
4	0	1	0	0	9	1	0	0	1

These binary columns have the value respectively of 8, 4, 2, and 1 (powers of 2); for example, 9 is one 8 plus one 1.

Another way decimal digits can be represented is in *biquinary notation* (like hands and fingers, or Roman numerals). In this notation the coding is:

Decimal	Biquinary 00	5	0	1	2	3	4	Decimal	Biquinary 00	5	0	1	2	3	4
0	1	0	1	0	0	0	0	5	0	1	1	0	0	0	0
1	1	0	0	1	0	0	0	6	0	1	0	1	0	0	0
2	1	0	0	0	1	0	0	7	0	1	0	0	1	0	0
3	1	0	0	0	0	1	0	8	0	1	0	0	0	1	0
4	1	0	0	0	0	0	1	9	0	1	0	0	0	0	1

These columns have the values 0, 5, 0, 1, 2, 3, 4. Seven, for example, is one 5 and one 2, 0100100. This notation was actually used in one of the big relay computers produced by Bell Telephone Laboratories, because the feature that two and only two pulses occurred in each row was useful for checking purposes.

Now, how do we convert biquinary notation into regular binary notation? This we can do with rectifiers in a function table. But how can we design the function table? That is easily done with one of the neat techniques of Boolean algebra (one of the algebras of symbolic logic), which has been alluded to from time to time in this series of articles. Here is the way. See Fig. 1 and Fig. 3.

Let's say that the A terminals are the 0, 1, 2, 3, 4 lines of the biquinary notation and the B terminals are the 00, 5 lines. These will be input. Let us say that the C terminals are the 1, 2, 4, 8 lines of the regular binary notation. These will be output. What conditions do we have to arrange?

Well, the C8 line is to have a pulse if and only if the B5 line has a pulse AND either the A3 line OR the A4 line has a pulse. Let us use "•" for AND and "v" for OR. Then we can write:

$$C8 = B5 \cdot (A3 \vee A4)$$

where C8 stands for 1 if the C8 line has a pulse and 0 if the C8 line does not have a pulse (remember those truth-values?). We can also write down at once the other conditions:

$$C4 = (BO \cdot A4) \vee B5 \cdot (AO \vee A1 \vee A2)$$
$$C2 = BO \cdot (A2 \vee A3) \vee B5 \cdot (A1 \vee A2)$$
$$C1 = BO \cdot (A1 \vee A3) \vee B5 \cdot (AO \vee A2 \vee A4)$$

Every operation that appears in these equations is either an AND or an OR. So we can just make up a function table, connecting the lines with rectifiers, in just the fashion that the equations tell us to. The result appears in Fig. 3.

Sample code

Now let's take a look at Fig. 3 and see how it works on a particular case. Suppose we want the number 7 in biquinary, 0100100, changed into the number 7 in binary, 0111. We use red numbers to stand for the values of the voltage, and put on each line in the circuit the value of the voltage which it will have. Line B5 and A2 will have the voltage 1. Consequently, vertical lines AO v A1 v A2, A2 v A3, A1 v A2, AO v A2 v A4, will have the voltage 1. Also the horizontal lines B5 • (AO v A1 v A2), B5 • (A1 v A2), B5 • (AO v A2 v A4) will have the voltage 1. As a result, lines C4, C2, C1 will have the voltage 1 and the C8 line will have the voltage 0. So the circuit works.

In the same way, other function-table circuits can be designed by simply writing down the conditions in convenient notation with AND and OR. If NOT or EXCEPT occurs, we use the negative of the pulse.

Input and output

The relation of input and output to the rest of an electronic computer is shown schematically in Fig. 4. The choice of input for a small computer would be either magnetic tape or punched paper tape (for discussion of magnetic tape see article VIII). The choice for a large computer would be magnetic tape only; paper tape would be too slow. A mechanism feeds the tape past a reading device; the reading device converts the patterns of punched holes or magnetized spots, possibly through a function table, into appropriate patterns of pulses to be used or stored in the computer.

The choice of output for a small computer would be an electric typewriter, a paper tape perforator, or a magnetic tape recorder (one that could record discontinuous pulses, irrespective of continuous sound recording). The choice for a large computer would be only magnetic tape recording, for the others would be too slow. Some special large computers record also in a pattern of bright and dark spots on motion picture film, which is then developed. This of course is nonerasable storage.

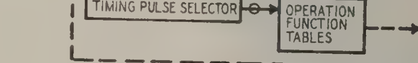

Fig. 5—Block diagram of the computer.

Both input and output give rise to problems of translation. For example, the number 7 expressed as 0111 in magnetized spots is to be translated into the number 7 expressed as 0111 in pulses circulating in a delay line. To carry out this translation, simply, cheaply, and reliably is an important engineering problem, although it does not appear as a problem at all in the logical design of the machine.

A block diagram

We shall now redraw the block diagram of Fig. 4 in an expanded form, showing what may be called the "block diagram of an electronic computer." See Fig. 5. The "o" drawn on each of the flow lines indicates a gate (an AND circuit or an EXCEPT circuit), which may or may not be open allowing information or timing pulses to flow or not flow. The group of units together marked

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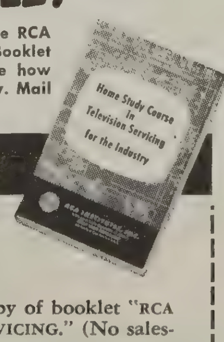

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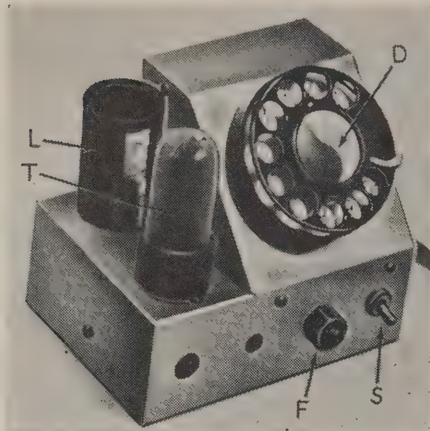

Telephone dial remote control unit operates stepping relay at receiver site.

TELEPHONE DIAL PULSES REMOTE CONTROL CIRCUIT

Pulsed oscillator sends messages to remote unit

By RANE L. CURL

IN ORDER to control a number of circuits by carrier from a remote unit, the following device (see photo) was designed. The oscillator is a Hartley, pulse modulated by a telephone dial. The carrier pulses actuate a receiver (cold-cathode tube) at a distance, which drives a stepping relay through a few necessary relays. The transmitter is built on a separate small chassis.

D,F,L,S and T refer respectively on the photo to the telephone dial, fuse, coil, switch and 117N7 tube.

The tube selected was a 117N7-GT (see circuit, Fig. 1) so as to eliminate the filament transformer. The diode unit in the tube was not used; a voltage doubler (full wave) was used instead. This supplies a sufficiently high plate potential to work over considerable distance. The voltage doubler is standard. Note that the power supply and filament supply are isolated from the line by an r.f. choke, CH1, so as not to short the signal from the transmitter to ground.

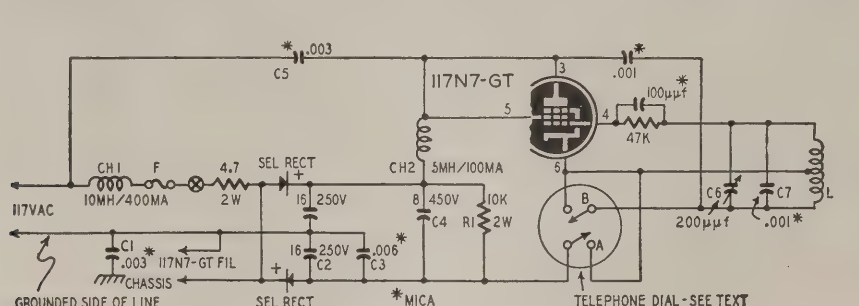

Fig. 1—Telephone dial pulse modulates the oscillator in this remote control.

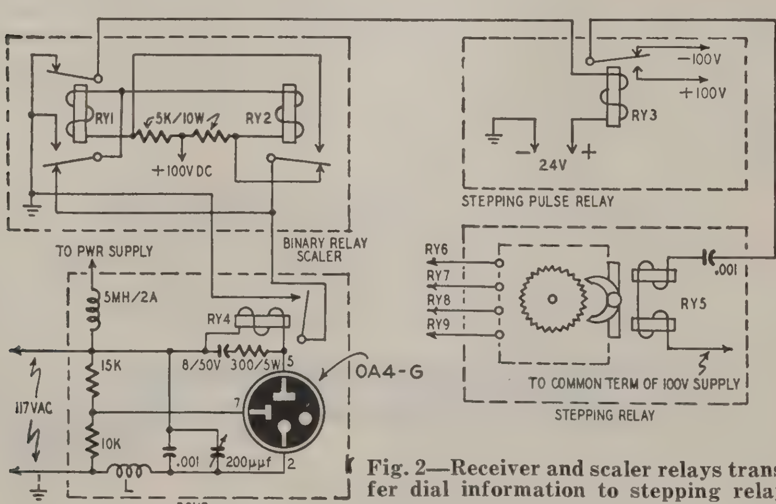

Fig. 2—Receiver and scaler relays transfer dial information to stepping relay.

R1 was necessary to obtain clean makes and breaks on the pulses. It maintains the potential across C4 at the transmitting value while the unit is idle.

Using the values given for L (120 turns, center-tapped, No. 26 enameled, 1¼-inch form) and C6 and C7, it is possible to obtain comparatively sharp resonance peak. Values may be varied to suit individual requirements, but a frequency in the range used by the author (approximately 300kc) is a good choice because of power-line attenuation of higher frequencies and component's size for lower frequencies.

The telephone dial was used to pulse the transmitter in the circuit depicted. However, the unit may be used for simple on-off single-pulse control. The pulsing operation is as follows: When the dial is started "up" contacts A close and initiate plate current in the tube. In idle or rest position the tube thus draws no current. After reaching the desired dial number the dial is released and the oscillator is pulsed by contacts B *opening*. Normally these contacts are closed, thereby producing a radio-frequency short between the plate and ground, and preventing oscillations. The transients present in opening these contacts are sufficient to initiate oscillations and the unit transmits until contact B again closes between pulses. This arrangement was necessary because of the dial's construction.

The value of C5 which couples the oscillator to the line is not critical. The first value chosen was 100 μμf. This put insufficient voltage upon the line so the value was increased to the present .003 μf. At this point the oscillator was still going strong so it is likely that even a higher value could be used with subsequent greater power output. In the writer's application too much power produced difficulties with the receiving equipment. The output is developed across CH2 so this should present a much higher impedance to the outgoing signal than does the coupling capacitor C5.

Capacitor C3 in parallel with C2 may not look right until one considers that an electrolytic capacitor at high frequencies acts only as a high resistance. In a typical electrolytic, all filtering or "capacitive" ability is lacking above 10,000 cycles. Capacitor C1 keeps the chassis at r.f. ground potential. This eliminates "body capacity" influences on the frequency of the oscillator. The chassis was *not* connected directly to one side of the power line (in accord with UL recommendations), but in use

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the device should be plugged in so that the output is into the hot side of the power line.

Relatively large changes in the value of C5 had only slight detuning affect upon the oscillator. The tendency was to lower the frequency of oscillation as the value of C5 increased, but this amounted to only a few kilocycles for a tenfold change in C5.

The receiver (Fig. 2) is a conventional circuit, with power supply (Fig. 3) employing the cold-cathode OA4-G tube. L is same as in Fig. 1, but not

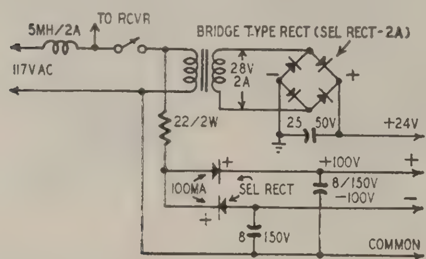

Fig. 3—Receiver and relay power supply.

tapped. A 10- and 15,000-ohm resistor keep the starting anode at a high potential so that the voltage developed across the tuning capacitors when a carrier of the right frequency is impressed on the line is sufficient to start a discharge. A.c. on the anode assures that the discharge is extinguished between pulses. The anode current of the OA4-G drives

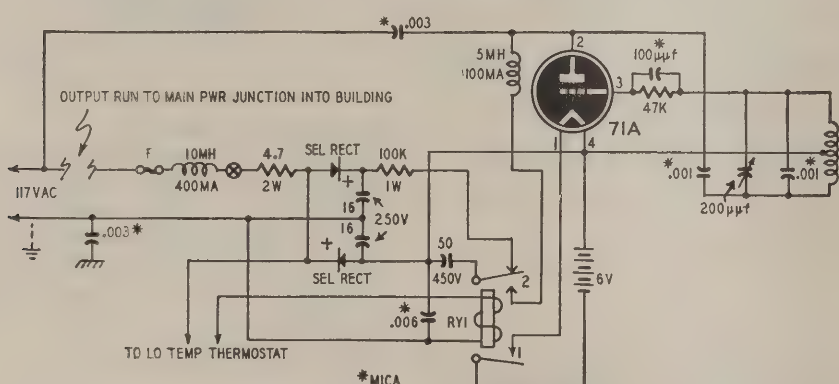

Fig. 4—Transmitter control circuit in greenhouse temperature warning alarm.

relay RY4 into a binary scaler arrangement. This is necessary since the stepping relay works from a source changing in polarity, so that in effect the stepping relay receives two pulses for each one into relay RY3.

The action of the binary scaler can be seen from the sequence of operations. (1) Relay RY4 is closed by the start of a pulse, closing relay RY1. (2) Relay RY4 is opened by the completion of a pulse, thereby allowing relay RY2 to close. (3) Relay RY4 is again closed by another pulse, *shorting out* relay RY1 this time and allowing it to open. (4) The completion of the second pulse from RY4 opens relay RY2. Each time that relay RY1 operated, it put one pulse through RY3 and therefore through to the stepping relay. This occurred only once per two pulses so the necessary scaling has been accomplished. A single pulse will reset the stepping relay at any time because of its construction. RY1 must make before break: RY2 break before make.

Greenhouse alarm

Fig. 4 shows an alarm circuit for a greenhouse, to give a warning if the power to the greenhouse failed or if the temperature fell below a certain danger level. (It could work equally well to warn if the temperature rose too high.) The greenhouse was some distance from the residence with power brought to it by buried cables. It was decided to use carrier warning.

If power should fail, a well-charged, high-value capacitor is inserted into the plate circuit by relay RY1 coincident with the lighting of the tube filament. The 71A was selected because it has a rapid heating filament. The oscillator transmits until the capacitor potential falls too low. This is for at least a second, which is plenty to actuate the receiver. The output of the unit must be connected ahead of the intermediate equipment which might fail, or else the pulse will not carry over the conduit to the residence. L is same as in Fig. 1.

If the power failure is general, a warning is still given by the receiver itself. Fig. 5 shows a receiver like Fig. 2, with some modifications. The same L is used. If pulse is received, relay RY1 closes, actuating relay RY3 which is self-locking on its own battery supply. This same battery also rings the alarm. The alarm is therefore not dependent upon the house power supply. If the power should fail generally, relay RY2 will open (it draws negligible current

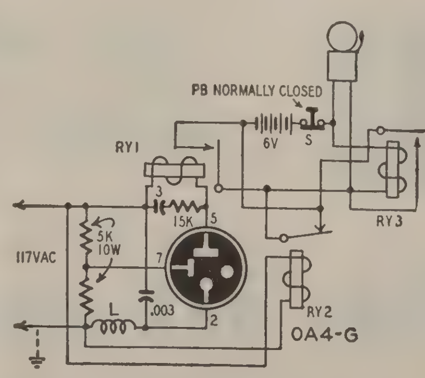

Fig. 5—Greenhouse alarm receiver circuit. Bell rings even if power fails.

on constant duty) and accomplish the same as the closing of relay RY1 by a pulse; relay RY3 will close and lock and the bell will ring. Pushbutton S, normally closed, resets the receiver conveniently. If power does not return immediately, the unit cannot be reset until it does.

A modification may be made to the circuit by inserting a capacitance (300 μf, 10 volt) into one lead to the *armature* on the relay RY2. An electrolytic would be best but if a paper capacitor is used it should be bypassed by a resistance of a few megohms. The result will be that if RY2 opens by an interruption of power, relay RY3 will be momentarily *pulsed*—it is hoped sufficiently long so that RY3 can take over and lock itself. Then while power remains off and S is depressed, relay RY3 will drop and will not return when the button is released. Relay RY2 will have to be actuated for only a few seconds to reset the capacitor by allowing its charge to leak off through the resistor, or through its internal resistance in the case of the electrolytic.

Other uses

Leads from the stepping relay go to other relays numbered 6, 7, 8, and 9 (Fig. 2). In practice up to ten relays can be used, corresponding to the numbers on the telephone dial, 1 through 0.

These multiple relays can be arranged to control numerous circuits around the house. For instance, a central control dial might turn on the coffee percolator in the morning. Its code might be dial C. Radio turn-on or turn-off might be dial R, and so on.

Although it might not be economically practical several dial units might be scattered around the house so that various activities can be carried on conveniently from several points. Experiment will show whether such installations would be feasible.

Materials for remote control

Resistors: 1—47,000 ohms, ½ watt; 1—4.7, 1—22, 2—10,000 ohm, 2 watts; 2—5,000 ohms, 1—15,000 ohm, 10 watts; 1—300 ohms, 5 watts.
Capacitors: (Mica) 1—.0001, 2—.001, 3—.003, 1—.006 μf. (Paper) 1—3 μf, 250 volts. (Electrolytic) 1—8 μf, 1—25 μf, 50 volts; 2—8 μf, 150 volts; 1—8 μf, 450 volts; 2—16 μf, 250 volts. (Trimmer) 1—200 μμf.
Chokes: 1—10 mh, 400 ma, 1—5 mh, r.f. 100 ma, 1—5 mh, r.f., 2 amp.
Relays: RY1, 5,000 ohms, d.p.d.t., make before break, RY2, 5,000 ohms, s.p.d.t., break before make, RY3, 300 ohms, 24 volts d.c., s.p.s.t., RY4, 1,200 ohms, s.p.s.t., RT5, stepping relay.
Miscellaneous: Tubes: 1—117N7-GT, 1—0A4-G. Tube sockets. 2—Single pole, single-throw switches. 1—Telephone dial. 1—Transformer, 28 volts, 2-ampere rating. L—see text for data. 1—Fuse holder and fuse. 4—Selenium rectifers, 100 ma, 1—selenium rectifier, bridge type, 2-ampere rating. Insulating washers. Wire. Hardware. Chassis. Solder.

Materials for Greenhouse alarm

Resistors: 1—47,000 ohms, ½ watt; 1—100,000 ohms, 1 watt; 1—4.7 ohms, 2 watts; 2—5,000 ohms, 1—15,000 ohm, 10 watts.
Capacitors: (Mica) 1—.0001, 2—.001. 2—.003, 1—.006 μf. (Paper) 1—3 μf, 250 volts. (Electrolytic) 2—16 μf, 250 volts, 1—50 μf, 450 volts. (Trimmer) 1—200 μμf.
Chokes: 1—10 mh, r.f., 500 ma, 1—5 mh, r.f., 100 ma.
Relays: (transmitter) RY1, 117 volt, a.c., d.p.d.t.; (receiver) RY1, 1,200 ohms, s.p.s.t., RY2, 117 volts, a.c., s.p.s.t., RY3, 6 volts d.c., locking type.
Miscellaneous: Tubes: 1—71-A (6A3 may be substituted). 1—0A4-G. Batteries: 2—6 volts. 1—Pushbutton, normally closed. 1—6-volt bell. 1—Single-pole, single-throw switch. 2—Selenium rectifiers, 100 ma. Chassis. Wire. Solder. Hardware.

—end—

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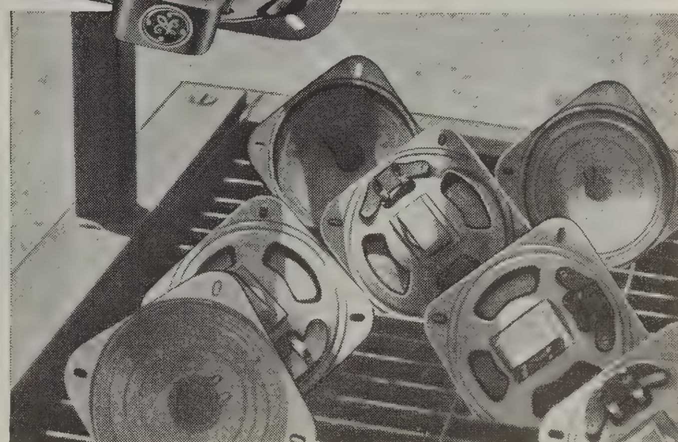

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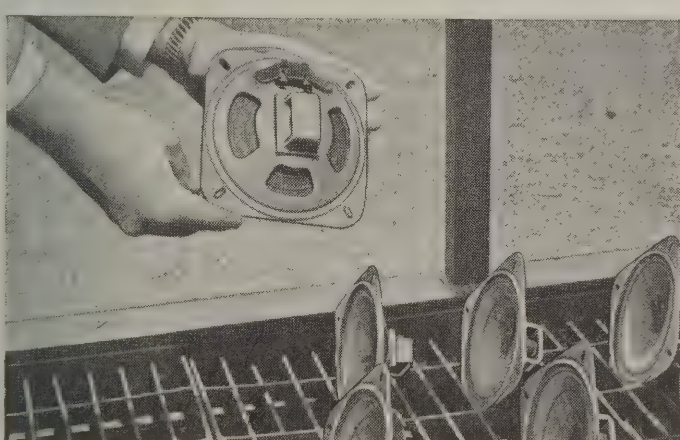
Unretouched photo shows only slight tarnish on speakers. Special G-E plating gives excellent protection to steel frames, none of which were corroded after grueling tests.



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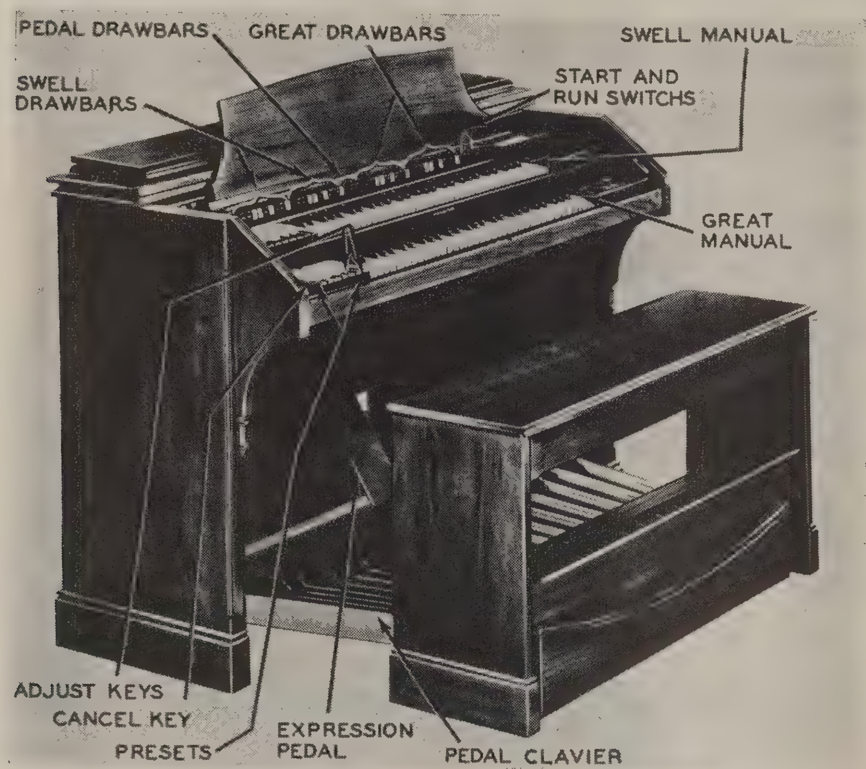
Electronics and Music

Part XV — The Hammond organ; music from spinning wheels and electric circuits

By RICHARD H. DORF



The Concert Model is similar to other Hammonds but has vibrato and more pedals.

THE Hammond organ is a notably popular instrument. This is not to say that other organs, for example, Baldwin, Wurlitzer, Connsonata, and others, are not equally good. In all cases, price, contemplated use, and other factors are involved.

In this article and the succeeding one we shall discuss the Hammond organ. In future articles other commercial instruments of the organ type will be taken up.

The block diagram of Fig. 1 gives a preliminary over-all view of the Hammond organ. The tone generator assembly generates a sine-wave tone of every pitch required, 61 for the 5-octave range, plus an extra 30 tones for use as harmonics and subharmonics in mixing tone colors, or 91 in all. Nine of these tones are fed to a 9-pole, single-throw switch assembly under each playing key, each pole carrying the tone corresponding to one of the harmonics or subharmonics of the tone represented by the key. The pedals operate 8-pole switch assemblies.

From the playing keys and pedals the tones go (through preset and adjust switches) to sets of drawbars. Each drawbar is an attenuator for one harmonic—the third, for instance. As the draw bar is pulled out step by step it increases the amplitude of the third harmonic of each note played on the manual controlled by that set of drawbars. There are five sets of drawbars, two for each of the two manuals and one for the pedal clavier. Which set shall govern at a particular time on a given manual is decided by whichever adjust key is selected. To set up a particular tonal "formula" on one manual, the player pulls out the drawbar corresponding to each harmonic to an extent corresponding to the amplitude of that harmonic he desires in the tone.

Preset panel

A preset panel is provided for each manual. This is an octave of 12 keys at the left of the manual, with colors reversed—black keys white, and white keys black. The second through twelfth of the preset keys are push switches; push one, it remains down and causes any other key down to spring up. Push the first (the lower C key) and it cancels whatever was down, then springs up itself.

The second through tenth keys (C-sharp through A) control certain preset *combinations* of harmonics. The eleventh and twelfth (B-flat and B) are adjust keys. They switch over to manual drawbar control and select the combination which the player has set up on one of the two sets of drawbars for each manual. Quick changes in registration are easy, requiring only a quick push of one preset or adjust key for each manual. There are no presets for the pedal clavier. Two drawbars are provided, one giving a combination of the lower-frequency harmonics and the other higher-frequency tones.

Tone emerging from the harmonic mixing system is fed to a matching transformer and then to an attenuator or expression pedal. Next it passes

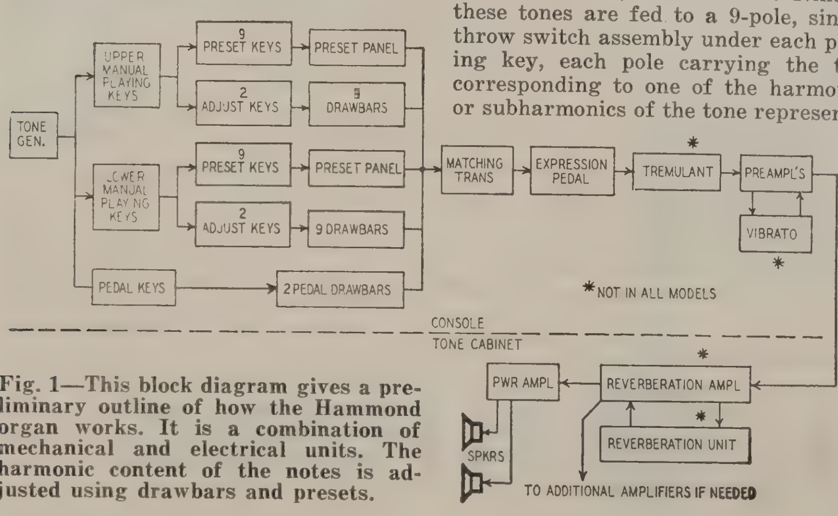


Fig. 1—This block diagram gives a preliminary outline of how the Hammond organ works. It is a combination of mechanical and electrical units. The harmonic content of the notes is adjusted using drawbars and presets.

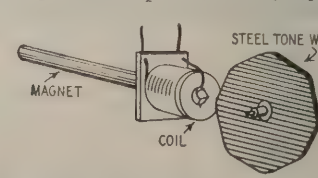


Fig. 2—A small voltage is induced in the pickup coil as the rotating steel phonic wheel varies distance to magnet.

through a tremulant, which is a motor-driven variable-resistance device to vary volume at the tremolo rate. Finally the tone reaches a preamplifier, combined with which may be a device which gives a vibrato effect—varying the pitch of the tones slightly at a rate of a few cycles per second.

The output of the preamplifier is fed to one or more loudspeaker units. Each contains at least one power amplifier and one may have a reverberation unit which gives the echo effect found in large halls. As many speaker units may be used as are necessary for the volume required.

The Hammond organ is made in several models. They all operate as above, but some lack features such as the vibrato or reverberation. Some have fewer notes in the generator assembly or pedal clavier, or fewer preset combinations. The spinet is entirely self-contained, including the speaker.

Tone generator

Fig. 2 shows how tones are generated. For each of the 91 tones, a steel phonic wheel rotates close to a magnetized bar on which a coil of wire is wrapped. Each wheel is accurately machined with a certain number of high and low points around its periphery. As the wheel rotates, the steel body is effectively brought closer to and farther from the magnetized rod with a frequency depending on the rotational speed and the number of teeth. As this occurs, there is a small change in the magnetic field. The field changes induce a small voltage in the coil at the frequency of the changes. The voltage is a.c. of roughly sine-wave form, and is, in effect, the generated tone.

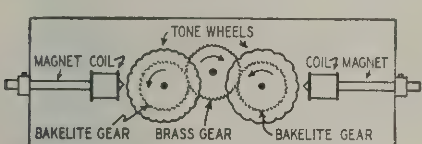


Fig. 3—Side view of tone generator compartment. Each contains four phonic wheels and pickup coils with magnets.

The long generator assembly contains 48 rotating assemblies, each including two phonic wheels. Since there are only 91 tones, five of the wheels are blanks, included for mechanical balance.

Drive assembly

The drive assembly has a long drive shaft. At one end of the shaft is the starting motor, a shaded-pole induction unit; at the other end is the synchronous running motor, which holds the speed of the shaft in step with the power-line frequency. Couplings to the motors are resilient so small instantaneous changes in speed due to line frequency variations are absorbed.

Along the drive shaft are 24 brass gears, two each of 12 different sizes. Within the assembly, the space is divided into 24 compartments, each containing one brass gear attached to the drive shaft and four tone wheels. Fig. 3 shows in cross-section one of the 24 tone-wheel assemblies. At center is one of the 24 brass gears on the drive shaft. This drives two bakelite gears, one on each side and each on its own shaft. At the two ends of each of the two subsidiary shafts is a tone wheel. There is a total of four in each compartment. Four magnetized rods with coils are provided, one for each wheel.

All the tone wheels within one compartment run at the same speed. Since there are 24 compartments (and brass drive-shaft gears), and since there are only 12 sizes of brass gears, two pairs of compartments contain wheels rotating at each of 12 speeds. Thus one speed is provided for each of the 12 tones of the chromatic scale. Tone wheels with 2, 4, 8, 16, 32, 64, and 192 teeth provide the 12 tones repeated at various octave intervals to fill out the complete range of the instrument.

The tone generator assembly is a unit of the highest precision. The steel of the phonic wheels must be homogeneous and exactly the same from one wheel to another. Machining of the wheel teeth must be precise to avoid introducing spurious harmonics and to get a good sine wave. The wheels must be dynamically balanced, and there must be no play in the gears. A synchronous motor actually runs in a series of pulsations and the pulsations must be ironed out. Resilient coupling from motor to drive shaft and similar couplings dividing the shaft itself are necessary.

Lubrication is important. The individual tone-wheel shafts are mounted in bearings of porous bronze. Each bearing is connected to an oiling system by a cotton thread. Capillary action carries oil from a reservoir trough. Proper maintenance includes using the grade of oil recommended, for mixing grades will gum up the cotton threads and prevent oil flow.

Sine wave output

The output of each tone generator must be as nearly sine-wave as possible. The tone coloring system requires this. The lower-frequency coils have copper rings on them. The eddy-current loss in the ring is low for the fundamental frequency but high for the harmonics. All the coils have simple filters at their outputs. As shown in Fig. 4, the first 43 coils are shunted with a resistor. The next five are fed through tapped transformers to reduce upper-harmonic content. The upper coils are fed through the transformers with a series capacitor; the capacitor and transformer make up a tuned circuit at the fundamental frequency. Each transformer is different, with the correct turns ratio and inductance for the frequency.

The entire generator assembly is built as one unit, and a new one can be substituted in case of damage or change to a location with a new line frequency. When the service technician orders a new assembly, however, he must give the model and serial number of the organ, as different generator types are not interchangeable.

Some models of the Hammond organ have a chorus generator in addition to the main generator. The chorus generator is similar to the main generator, and provides frequencies 56 through 91. Frequencies 56 to 67, however, are 0.8% sharp or flat, while the rest are 0.4% from the correct frequency. This slight difference between the frequencies of the two generators gives a chorus or ensemble effect of two instruments playing at the same time. It destroys the undesirable tuning of the electrical system.

The precise, perfect tuning of the electrical generation of tones destroys, some say, the very quality of music produced by ordinary acoustic instruments. These have an imprecision, or variation in pitch and tone quality, which gives the music warmth, life, and vibrancy. One of the major drawbacks, then, of making music electrically, is that this very quality of spontaneous, live, direct control of the tone, pitch, and quality of the music is not possible in an electric system.

Manuals and pedal clavier

Each of the 61 playing keys and each of the nine preset and two adjust keys for each manual actuates nine small bronze contact springs with precious metal points (Fig. 5). When the key is pressed, each spring makes contact with a busbar which runs the width of the manual.

Each contact spring (note shape, Fig. 6), is connected to the output of one tone generator. Resistance wire is used, the resistance affording isolation necessary because each tone generator is connected to a number of contact springs. This arrangement is the key to the harmonic synthesis tone color system employed in the Hammond electric organ.

The tones provided by the generator are the fundamentals of all the 61 notes

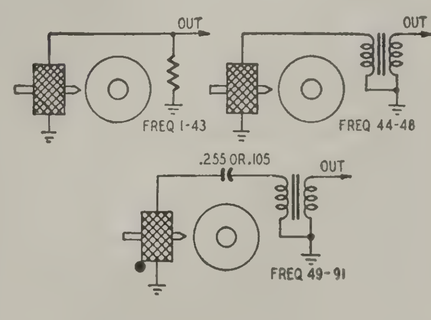


Fig. 4—There are three groups of pickup coils, divided according to frequency. Harmonic content is filtered from each.

plus another 12 below the lowest keyboard note and another 18 above the topmost one. Each of these tones is one of the 12 in the "well-tempered" scale with which we are familiar. In addition to being used as fundamental tones, however, they are also used as harmonics. For instance, suppose the lowest C on the manual is pressed and the fundamental drawbar is pulled out. The note heard will be 65.41 cycles (refer to the frequency chart on page 42, Au-

gust, 1950, RADIO-ELECTRONICS). Now, with the same key pressed and the second-harmonic drawbar pulled, the note heard will be 2 × 65.41, or 130.8 cycles, derived from the same tone generator which would furnish 130.8 as the fundamental for the C one octave higher.

The third harmonic for the lowest C key is derived from the same generator which also furnishes the fundamental for the G an octave and a half higher. The frequency of this generator is 196.0 cycles. The true third harmonic of 65.41 would be 196.2 cycles, however, so the tone used as third harmonic on the Hammond is really slightly flat. The

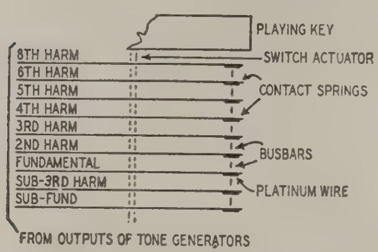


Fig. 5—Side view of one key assembly. Key pushes down actuator to make nine springs (carrying tones) hit nine busbars. Contacts are made of platinum.

fourth harmonic, 261.7 cycles, is the same as middle C, so there is no discrepancy. The fifth harmonic should be 327.1 (approximately) but the nearest tone which is also part of the scale as a fundamental is the E above middle C, which is 329.6, so again there is an error. The sixth harmonic should be 392.5, while the nearest available note (G above middle C) is 392.0, another error. The seventh harmonic should be 457.9, but the nearest are 440 and 493.9, neither of which is close enough to do. The seventh harmonic therefore is not used on the Hammond. The eighth harmonic is the following C at 523.3 and is perfectly accurate.

The so-called sub-third harmonic is an octave below the normal third harmonic and has the same error. The subfundamental is simply one octave below the fundamental.

The errors in harmonics are actually slight, the worst being the fifth harmonic. Not many listeners can tell that the harmonic structure is faulty. The effect, if audible, is merely characteristic of the instrument and is neither a fault nor a virtue. It would be economically unfeasible to furnish the necessary fundamental tones plus the additional generators needed to supply the exact harmonics for each note.

Mixing harmonics

The method by which drawbars and presets control harmonic mixture is ingenious and simple. Fig. 7 shows the entire tone coloring system. Note the set of busbars marked LOWER MANUAL. There are nine bars, one for each harmonic and subharmonic. These bars run the width of the console, under the playing keys, the preset keys, and the two adjust keys.

Each of the 61 playing keys actuates a set of nine vertical contact springs, as in Fig. 5. Each spring is wired to an appropriate tone generator and carries that tone continuously. A typical playing key, with its resistance-wire connections to the tone generators, is represented by the vertical set of contacts at the left of the lower-manual busbars in Fig. 7. All 61 keys are the same. Any number pressed at the same time make contact with the same set of busbars.

When a playing key is pressed, tones are sent to the busbars. The bottom busbar receives the sub-fundamental of the desired note. The next receives the subthird, and the third from the bottom gets the fundamental. Thus at any time, every bar may be carrying many different notes; but all the notes carried by any one bar are fundamentals, or third harmonics, and so on, depending on the particular bar.

In Fig. 7 there is a set of contacts representing one of the two adjust keys on the preset panel to the left of the playing keys. Let us assume that that adjust key is pressed and stays down. Following the wire from each adjust key contact we find that it leads to a contact on the end of a drawbar, and that there are nine drawbars in the group. We also find that the drawbar contact is at present sitting on the lower busbar of a group of nine attached to taps on the primary of a matching transformer. Note well at this point that the number of nine transformer

Fig. 6—Resistance wire is used in contact spring to isolate it, because each tone generator connects to several springs. Platinum contacts bus-bar.

taps and tap busbars has no relation to the nine bars below corresponding to the harmonics. There might just as well be 12 or four taps and tap busbars.

A sample tone

The lowest transformer tap and busbar is grounded. Trace the circuit now for, say, the fundamental tone. The generator terminal for this tone is connected through a resistance wire to the contact spring of the corresponding key. That spring is contacting the third busbar from the bottom (lower manual). The tone then goes through the corresponding adjust key contact to the third drawbar, which is contacting a grounded transformer busbar.

Now suppose we pull out that third drawbar one notch. The contact at its end is now connected through the second busbar from the bottom to the first transformer tap up from ground. A small voltage appears in the transformer primary and the secondary shows some output of that tone. The output increases by pulling the drawbar out more, placing the tone across a larger section of the transformer primary.

Suppose we also wish some sub-fundamental output. Sub-fundamental tone is reaching the first drawbar *via* the lowest lower-manual busbar and the lowest adjust-key contact. By pulling out the first drawbar, we introduce some sub-fundamental. Thus, by simply pulling out drawbars to the desired step, we can produce in the output a tone in which are mixed all the harmonics and subharmonics in any tone quality formula. Because all the lower-manual playing keys send tones to the same set of lower-manual busbars, the drawbars control the identically numbered harmonics of all the keys pressed at the same time.

A second set of drawbars (not shown) is furnished for each manual, with a second group of adjust-key contacts on the lower busbars. It is possible to set up the drawbars in advance for a certain mixture formula, then bring that mixture into play by pressing the unused adjust key. This releases the first adjust-key contacts, taking the first set of drawbars out of action, and makes the contacts for the second drawbar group. All the action we have discussed is identical for both manuals.

Preset operation

The preset keys determine certain standard formulae, and are a part of the same system. As Fig. 7 shows, one lead from each transformer tap is brought down to an auxiliary set of busbars known as the preset panel. Each of these bars has a large number of screw terminals along its length.

Each preset key has nine contact springs which, when the key is pressed, make contact with the same group of nine busbars as is used for the playing keys. This, when a preset key is pressed, its nine contacts pickup from the busbars the nine tones corresponding to the harmonics of whatever playing keys are being used. These nine tones appear in a group of nine color-coded wires which come up through a hole below the preset-panel busbars on the back of the organ case.

To set up a present combination, the coded wire carying each harmonic is attached with a screw to the appropriate preset-panel bar corresponding to the strength with which that harmonic is desired in the combination. For instance, if no sub-fundamental is desired, the red wire (which leads to the lowest contact of that preset key on the lower-manual busbar group) is connected to a terminal on the lowest bar of the preset panel. Since that bar is wired to the grounded end of the transformer primary, the wire is effectively grounded. If loud fundamental is desired, the orange wire, connected, when that preset key is pressed, to the third busbar of the manual, may be connected to the top preset-panel bar, which puts it across the full transformer primary for full output.

Changing presets

The organ is shipped from the factory with preset combinations already

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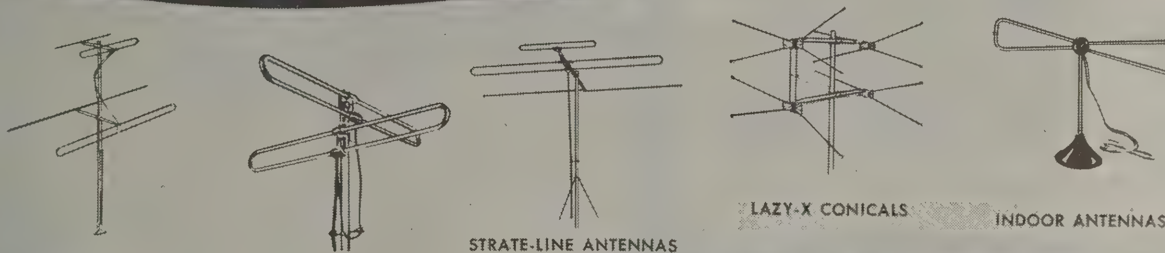

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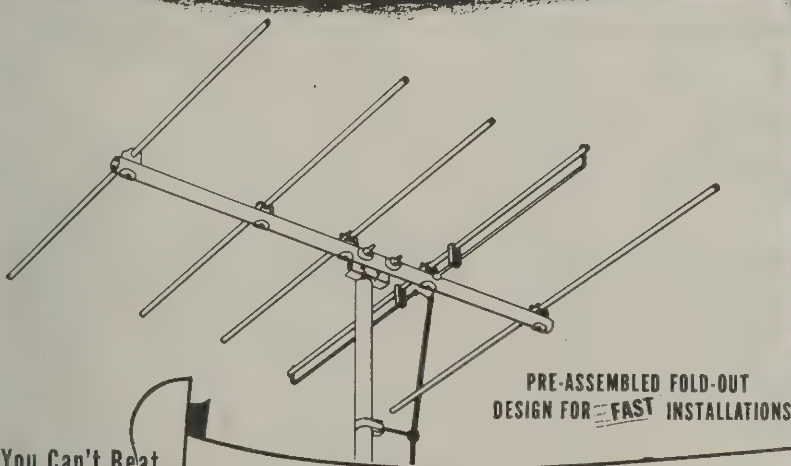

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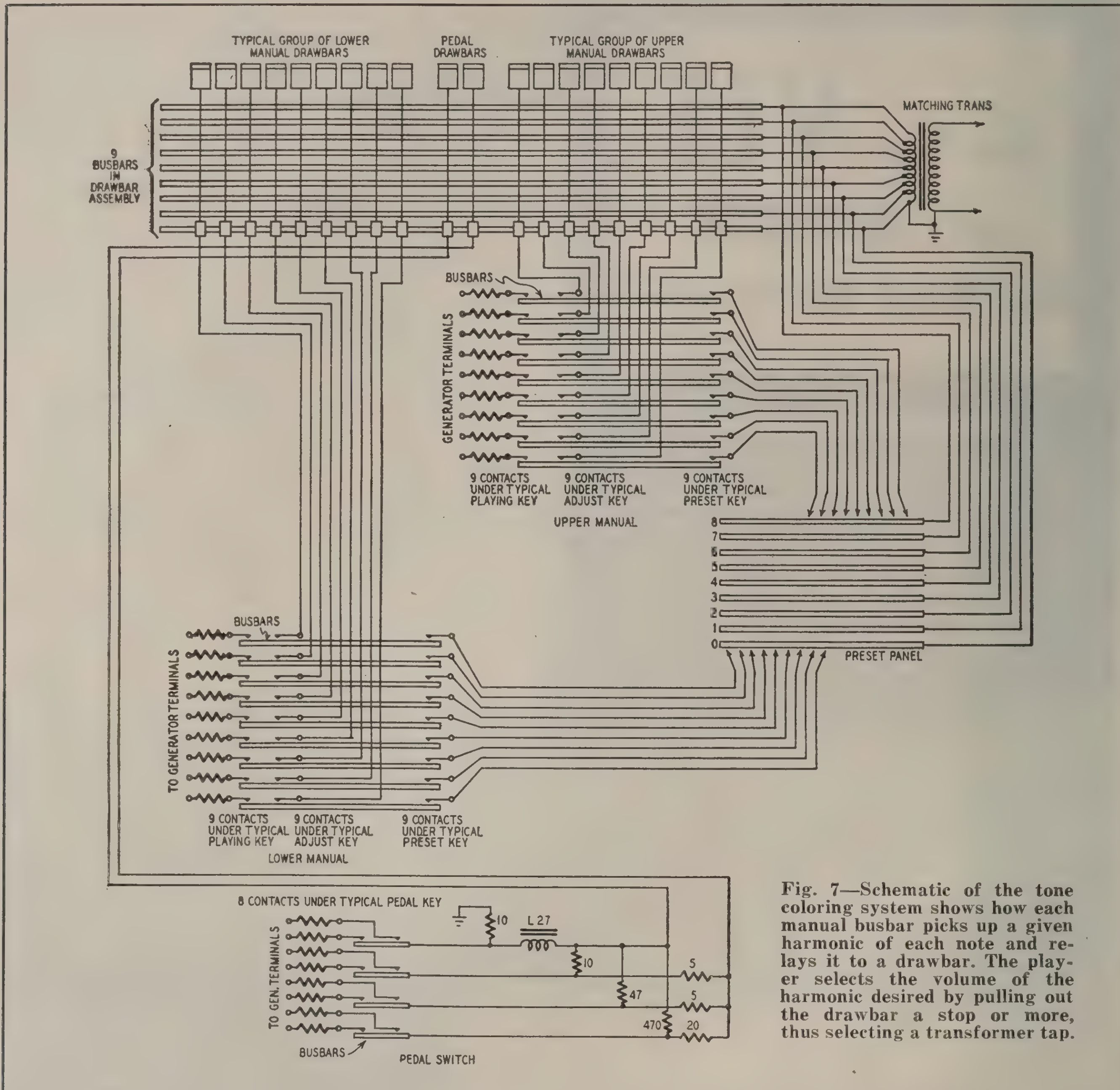


Fig. 7—Schematic of the tone coloring system shows how each manual busbar picks up a given harmonic of each note and relays it to a drawbar. The player selects the volume of the harmonic desired by pulling out the drawbar a stop or more, thus selecting a transformer tap.

made up and the wires connected. Individual owners, however, often wish to change the presets for their own favorite tonal varieties. To do so, the experimentation is done with a set of manual drawbars, with, of course, the appropriate adjust key pressed. Then the positions of the drawbars are noted in terms of how many steps each has been pulled out. With a screwdriver in his hand and a list of the drawbar numbers, the owner or service technician may reconnect the preset wires as desired, keeping in mind that a connection to the lowest preset bar simulates a drawbar pushed all the way in and connection to the highest gives the effect of a drawbar pulled all the way out. The preset panel is, in effect, 9 sets of drawbars fixed permanently in position. Enough terminals are provided on the preset busbars so that all 9 preset keys can be set up as desired.

Table 1 below gives the color coding of the present key wires.

Table 1

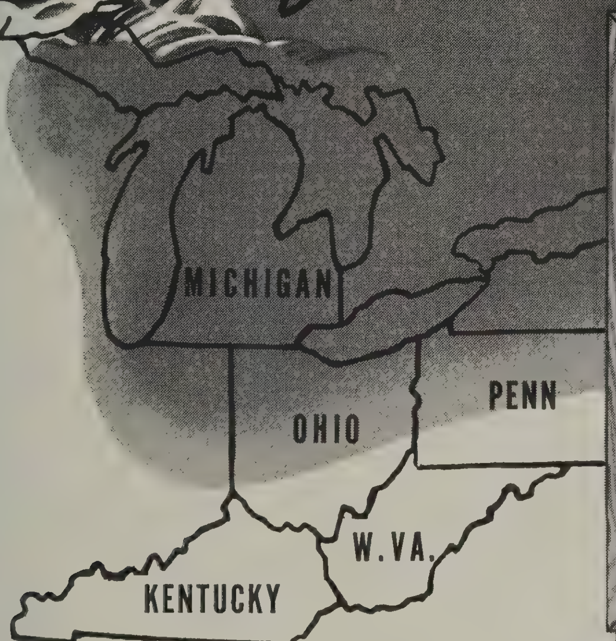
Harmonic	Wire color
Sub-fundamental	Brown
Sub-third harmonic	Red
Fundamental	Orange
Second	Yellow
Third	Green
Fourth	Blue
Fifth	Violet
Sixth	Grey
Eighth	White

Pedal drawbars

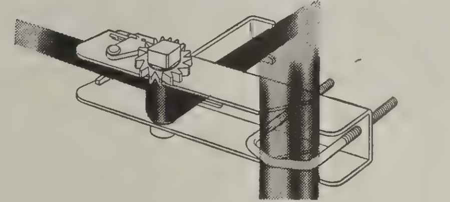
The pedal drawbars work on the same principle as the manual drawbars but the wiring is different and there are no presets. In some models fundamental through eighth harmonic tones are used; in others the tenth and twelfth are added. In each case, however, two harmonics are fed to each pedal busbar, as indicated in Fig. 7. The outputs of all the busbars are mixed with a resistor system and two outputs are derived, one predominant in low and one in high harmonics. These are fed to two drawbars which control pedal tone quality in a much less exact and selective manner than for the manuals. This is justified because the pedal is ordinarily used only as a "foundation" tone to add a solid bass to the ensemble, and it is rare to play two pedal notes simultaneously.

In next month's article we shall complete the Hammond organ description with the amplification system, tremulant, vibrato, expression control, pedal solo unit, and tone cabinets. We shall also include a "numbers table" giving such statistics, and other details.

(continued next month)



BUY OF THE MONTH



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GENERAL ELECTRIC

181-KA9

Audio Feedback Design

Part XI—Low distortion single-frequency signal generator uses a feedback circuit

By GEORGE FLETCHER COOPER

FOR the last few months we presented a considerable amount of (necessary) mathematics. This month's offering may therefore be a welcome change to those readers who dislike mathematical treatment, as well as to editors. Editors react to mathematics as ordinary mortals react to alcohol; a small dose makes them smile happily, but on a larger shot they go fighting mad. Before we return to audio completely, however, there is one feedback system which offers a little of everything; a designer's smörgåsbord, hors d'oeuvres, hot-pot or junkbox, as you will.

You will have read dozens of articles on new designs of high-fidelity amplifiers: how often has the designer told you where you can get a correspondingly high-fidelity input? If you have 0.2 volts of input, you get 10 watts of true and faithful copy; but copy of what? The output from a receiver of unknown performance, or pickup which seems to sound quite good? In the ground-ray region, of course, there's WWV. Elsewhere, a signal generator must be used, and the average commercial unit is not good enough.

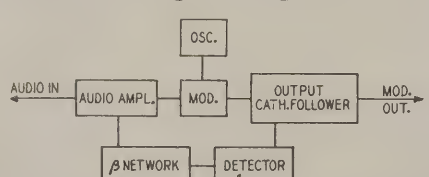


Fig. 1—Single-frequency generator showing feedback components and loop.

The solution was to build a special signal generator. For my purposes, 0.5% distortion up to 50% modulation was good enough. Mr. Sampson* of G-E has described a similar but more elaborate circuit, which has 0.1% distortion at 100% modulation. In this article I shall describe my own circuit with emphasis on feedback circuit design because it contains all the basic elements to be considered.

The performance can be improved by elaborating the modulator and detector but these do not involve the feedback loop. The signal generator is a single-frequency unit. The commercial design by Sampson requires six adjustments when changing frequency, but for receiver testing it is always possible to tune the receiver to the generator.

**Electronics*, Apr., 1949; *Proc. Nat. Elec. Conf.*, 1948.

To simplify arithmetic, I shall not follow my own design exactly, but will use a design carrier of 800 kc in this article. Any type of modulation may be used, so it is quite easy to run comparative tests on the signal generator and receiver, using a microphone or tape recording as source. A good audio oscillator is used for normal distortion measurements.

The basic circuit diagram is shown in Fig. 1. It looks exactly like a feedback amplifier, except that inside the forward path there is a modulator, and in the feedback path there is a detector.

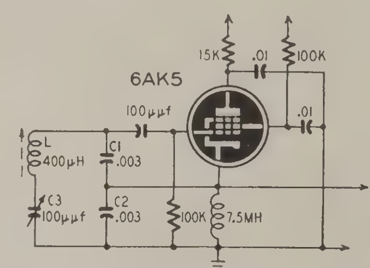


Fig. 2—Circuit of the master oscillator.

Ideally, just as in the ordinary audio feedback case, the performance depends only on the feedback path, so that instead of needing to design a good modulator, all we must do is produce a good detector.

In practice, just as we make our audio amplifiers as good as possible before we apply feedback, here we try to get a good modulator, because we cannot apply unlimited feedback. The problem is to decide what we mean by amplitude and phase characteristics when one part of the circuit works at audio frequencies and another at 800 kc. First, consider the component parts of the system which take the place of the individual stages of an ordinary amplifier.

Oscillator circuit

The master oscillator circuit, Fig. 2, is the highly stable Clapp-Gouriet circuit. It was incorporated because we wanted to see whether it was as good as reported. If a new oscillator appears while you are building a signal generator, by all means try it! In case you have forgotten about the Clapp-Gouriet circuit, I have shown the bare bones of this circuit together with the Colpitts circuit in Figs 3-a and 3-b. The tank circuit capacitors of the Colpitts are made very large, and the necessary small inductance is obtained by series tuning a normal inductance. The oscillation frequency is just above the series-resonance frequency of the LC branch. The main disadvantage of this circuit in some applications is the rather low output, but we only need about 1 volt for the modulator grid.

The modulator

The modulator uses a 6AS6 tube. This is like the phantastron, and has a relatively high suppressor mutual conductance. Suppressor modulation is frequently used at moderate power levels, 10–50 watts, but most small pentodes require at least 50 volts on the suppressor to cut off the plate current. In the 6AS6, 5 volts on the suppressor will cut off plate current. The exact figure depends on screen and plate voltages. It makes a convenient modulator for this circuit, because the oscillator and audio inputs can be completely isolated by applying them to separate grids. The circuit, shown in Fig. 4, provides cathode degeneration at audio frequencies, because the 3,000-ohm resistor is only decoupled to radio frequencies. The result is the modulator gives fairly low distortion up to about 50% modulation.

The output is taken from a cathode follower so that the load does not react back on the circuit. The external load is tapped down on the cathode-follower resistor, because we require only small outputs and we can use the decoupling produced by this resistive attenuator. An external attenuator was used to control the level, but a tapping slider on the 75-ohm resistor could be used. We can neglect the frequency response of the cathode follower, fortunately, so that we need not put in the actual circuit at this point.

Detector

The key to the feedback loop is the detector. A germanium diode, together with a filter circuit to eliminate the radio-frequency components, provides audio voltages which can be connected back into the audio amplifier. The circuit of this is shown in Fig. 5. It would

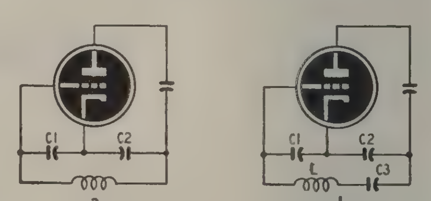


Fig. 3—(a) Colpitts; (b) Clapp-Gouriet.

be a considerable improvement to add extra carrier at this point to keep the effective depth of modulation very low. The Sampson circuit does this but unless you expect to be working in the region below 1% with your receivers it is not worth going to the extra complication involved.

These bare bones must now be assembled into a complete circuit, with its feedback loop closed. As we saw in the last article, the r.f. stages operate right down to zero modulation frequency. Therefore regarding low-frequency audio response only one RC circuit has any effect, and we cannot possibly have low-frequency instability. All our problems are concentrated on the high-frequency audio response.

Circuit problems

Three circuits affect circuit behavior for high modulation frequencies: the plate circuit of the audio amplifier; the plate circuit of the modulator; the smoothing circuits in the detector. Let

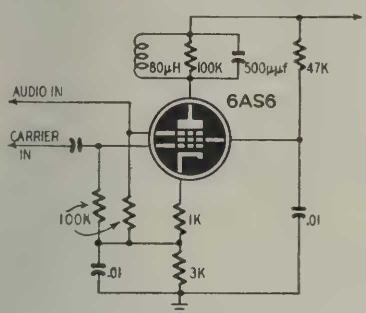


Fig. 4—Modulator circuit provides cathode degeneration at audio frequencies.

us consider them separately, and put in numbers which look reasonable: if the result is not satisfactory we must make the changes suggested by the shape of the curves. I am trying, as always in this series, to take the reader right along with me in working out the design. Most of the interest lies in the spots where you go wrong!

The audio amplifier is quite conventional and its main purpose is to provide a convenient means of connecting the feedback into the circuit without using a very large feedback voltage.

The audio amplifier has a plate resistor of 100,000 ohms and a total capacitance, including wiring, which should not exceed 20 μμf. The characteristic frequency,

$$\omega = \frac{1}{CR} = \frac{1}{20 \times 10^{12} \times 10^5}$$

$$= \frac{1}{10^{-7} \times 20} = \frac{10^8}{2} = 500{,}000$$

$$2\pi f = 500{,}000$$

$$f = 80 \text{ kc},$$

is therefore 80 kc. We can afford to put in a stabilizing circuit here, and a convenient design frequency is 8 kc. The

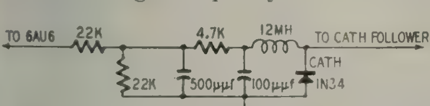


Fig. 5—Germanium diode detector circuit.

capacitance is therefore 200 μμf. If 20 μμf gives a frequency of 80 kc, then 8 kc will give (since capacitance is inversely proportional to frequency) a figure of 200 μμf. The point at which we flatten out the characteristics settles the amount of phase shift we shall have, and I shall guess the value of resistor to be used as 27,000 ohms. This makes the response of the audio stage flatten out about 14 db down, and moves the final cutoff up to 400 kc. These values are the sort of values I have been using in a lot of audio circuits, so this guess has pretty strong inspiration.

For the plate circuit of the 6AS6 we can start from several different assumptions. To get stable tuning without the tube capacitance having too much effect, the capacitance must be at least, say, 100 μμf. The corresponding inductance, for a frequency of 800 kc, is 400 μh,

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

$$\sqrt{LC} = \frac{1}{6.28 \times 800{,}000}$$

$$\sqrt{L \times 100 \times 10^{-12}} = \frac{1}{50.24 \times 10^5}$$

$$L = 400\ \mu h,$$

and the plate impedance is 2,000 × Q ohms: Q is the figure of merit of the plate circuit inductance. The coil itself will give us a Q value in the order of 100, but the tube characteristics suggest that Q = 10, giving 20,000 ohms plate load, would be more suitable.

Let us look at it another way. You may remember from the last article that the bandwidth associated with a given resistance and capacitance is unaltered by moving from audio to bandpass problems. Since we are to work with audio frequencies up to about 8 kc, the bandpass bandwidth must be about 16 kc. Taking 20,000 ohms as the desired resistance value, we have

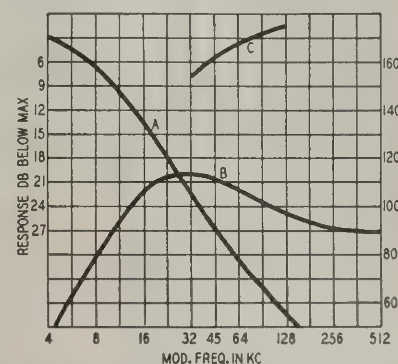
$$20{,}000\ C \times 2\pi \times 16{,}000 = 1$$

$$C = 1/2000\ \mu f = 500\ \mu\mu f.$$

The use of 100 μμf, giving a bandwidth of 80 kc, would mean that the envelope response was 3 db down at 40 kc modulation frequency, and that the gain was only about 40 db down at audio frequencies. Too much audio would then come straight through to the output. Let us switch designs to the 500-μμf, 80-μh basis, and make sure that we get a Q of 50. An ordinary slug type, dust-core coil will do the job.

In designing the detector circuit we have another problem. We want to keep the radio frequency out of the feedback loop, but yet not produce too much phase shift at audio frequencies. The detector network, of course, is an audio network: it is only in the modulator that we have the bandpass type of circuit. To find what we need we must construct the amplitude and phase response characteristics for the portions of the circuit already designed. Those are shown in Fig. 6.

If we assume that we want to put on 20 db of feedback, we can take a 7-db margin and make sure that the phase shift is less than 180° at 45 kc. Looking up low-pass filters in reference tables we see that a full section of constant-K low-pass filter has a phase shift of 180° at cutoff, and a phase characteristic roughly linear with frequency.



A-AMPLITUDE RESPONSE; B-PHASE RESPONSE WITHOUT DIODE FILTER; C-PHASE RESPONSE WITH DIODE FILTER

Fig. 6—Amplifier and phase responses found with templates of previous articles.

Usually it is slightly concave downward, so that we get a slight safety margin thrown in if we take the phase as proportional to frequency. By taking a cutoff frequency of 3 × 45 kc = 135 kc, we shall have only 60° phase shift at 45 kc, making the total phase shift here 170°. As I have not used a full section, but have replaced one inductance by resistance, the filter is slightly safer than the design suggests. This network will give us 30–40 decibels attenuation at the carrier frequency, so that there is no danger of carrier overloading the audio amplifier.

As a filter design impedance we take 10,000 ohms. The inductance and capacitance are then:

$L = R/2\pi fc = 10{,}000/6.28 \times 1/135{,}000 = 11.7$ mh

$C = 1/2\pi fcR = 1/6.28 \times 1/10{,}000 \times 1/135{,}000 = 117\ \mu\mu f$

These values are convenient, and the final network is shown in Fig. 7.

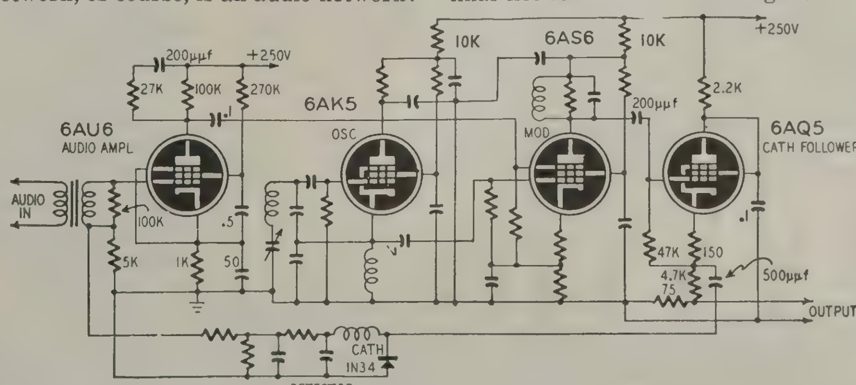


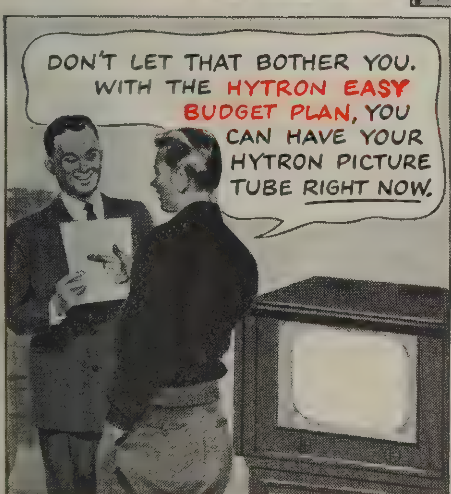
Fig. 7—Circuit of the feedback signal generator shows values not included in the previous partial circuit diagrams. A regulated power supply is suggested.

It is necessary to know the total gain round the feedback loop to make sure that one audio stage is enough. The audio amplifier, with a plate load of 100,000 ohms and about 1 ma plate current, where the mutual conductance is low, will have a gain about 40 db. The modulator has a conversion conductance of about 500 μmhos, but the cathode feedback brings the gain down to not much more than unity. Let us assume a gain of 100 from audio grid to detector. This is just about enough to make the system conform to the standard feedback theory, for we have $A = 100$, $B = 1/10$, and $AB = 10$. Final adjustment of gains and feedback is done when the model has been built.

Tuning modulator plate

The most important detail in the construction of this signal generator is the tuning of the modulator-plate circuit. It must be tuned exactly to the oscillator frequency. If the modulator is detuned by 8 kc, there will be an extra 45° phase shift on one side or other of the carrier, and the system will be unstable with full feedback. It is not easy to tune on amplitude alone, because the response is only 30% down at 45° phase shift. The phase is very dependent on tuning, so this can be used as a guide: the tuning is rocked to the unstable point on either side of the center frequency, and the mean position used as a final setting.

In the form in which I have been using it, this signal generator, designed for operation at 5 mc, gave a distortion of 0.9% at 90% modulation, and less than 0.5% at 50% modulation. The output was about 100 millivolts, which is more than is needed for any normal receiver test. The level required to modulate it fully was less than 0.1 volt on the grid of the audio amplifier: the input voltage depends on your choice of input transformer.



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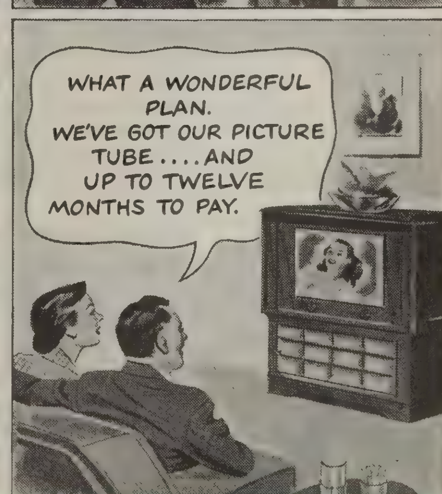

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From the feedback aspect the point of interest which this system has illustrated is the way in which audio and modulated radio frequency systems can be combined in a single feedback loop, using exactly the same ideas of amplitude and phase response as are used in the audio systems alone. Transmitter designers and other high-level engineers use this technique regularly, but most people commonly think of negative feedback for audio only. So long as you remember that the system is intended to pass audio through, and all speech devices are meant for just this, you need only keep an eye on the audio amplitude and phase response. The carrier, like the d.c. on the telephone local circuit, can be allowed to look after itself.

Before leaving this special mixed system and returning to more everyday matters, there is a reversed form of this signal generator which the reader can think about himself. Suppose that you take the audio output from your FM receiver, add a reactance tube in shunt with the local oscillator, and modulate the local oscillator by means of the audio output. The result will be to provide feedback round the discriminator loop. Exactly the same design procedure must be used for this case, provided you can keep the audio in mind. If you think about the problem you will see that trouble arises from the multiple side frequencies; the audio is no longer just one side frequency, and it is hard to see what the phase means. There is an amplitude-modulated version of this problem too. I do not propose to write anything about these particular devices, but I mention them here just to set you thinking, and to encourage you to plan new combinations for yourself.

—end—

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The output voltage varies with the make and model of the motor. I use a 250-volt Sangamo motor which delivers 13 volts peak into a high-impedance load such as an oscilloscope or the grid of an amplifier tube.—*J. Ratcliffe*

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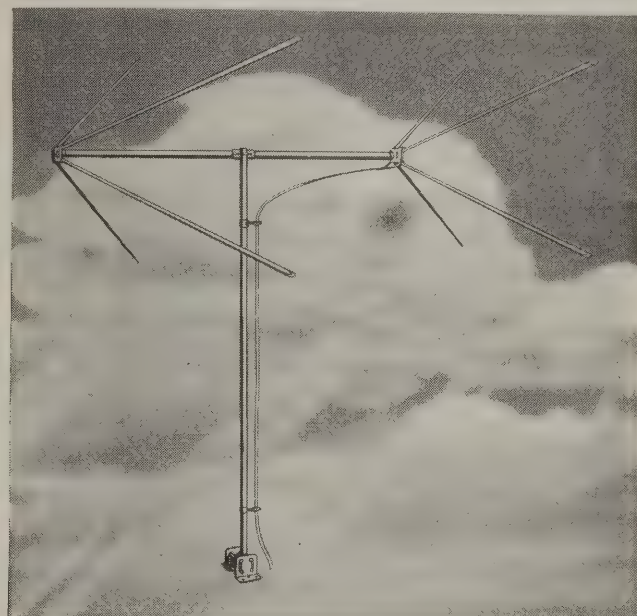

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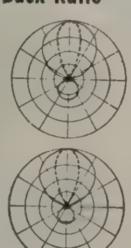

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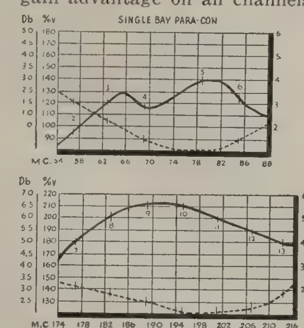

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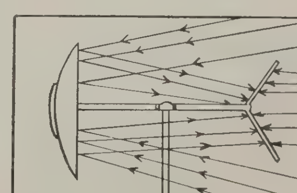

Diagramatic sketch showing how parabolic reflectors gather in and concentrate energy on conical elements.

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By JOHN RUNDO

A PREVIOUS article (September, 1950) described a 30-watt amplifier with an unusual tone-control circuit and high-gain phase splitter. This article applies these circuits to an a.c.-d.c. amplifier. Design of such an amplifier presents two problems: appropriate output tubes, and a high-current power supply.

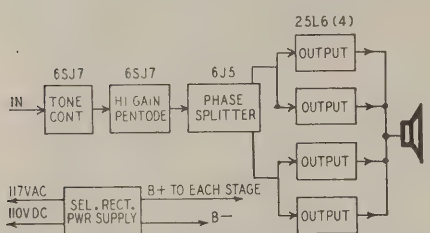


Fig. 1—Block diagram of the a.c.—d.c. amplifier that has high power output.

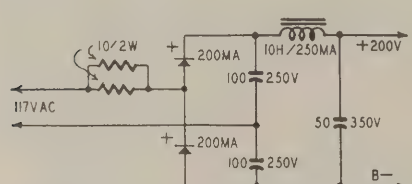


Fig. 2—Voltage doubler circuit for the amplifier. This is for use on a.c. only.

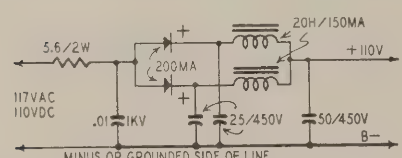


Fig. 3—This power supply for the amplifier can be used on both a.c. and d.c.

Considering the first, tube manuals show that a single tube of the 25L6 type requires 50 ma at 200 volts for 3.8 watts of audio output with 10% total harmonic distortion. Generous negative feedback (20 db) can reduce the harmonic distortion to better than 1%. To obtain *clean* audio at sufficient power it is obviously necessary to use four tubes in push-pull parallel. Allowing 50 ma plate current and 7 ma screen current per tube, the four 25L6's require 228 ma; with three tubes preceding the output stages (see block diagram, Fig. 1), this is further increased to about 245 ma.

Selenium rectifiers are the best choice for the power supply, owing to their compactness, low internal resistance, and high current output, especially as they develop much less heat than vacuum tube rectifiers. The only serious disadvantage of the metal rectifier in the present application is the fact that the B-supply is ready immediately after switching on. Because of the high current taken by the output tubes and an appreciable time-lag before their cathodes have reached full working temperature, it is *essential* to introduce a delay before applying the full B-supply, or the cathodes will be damaged.

B-supply and its delay

The standard 117-volt a.c. line voltage means that a voltage doubler circuit must be used to supply 200 volts d.c. at 245 ma without a transformer, Fig. 2. With this arrangement nearly 20 watts output is possible at fairly low distortion.

Operation for 110 volts d.c. presents another problem. It is not possible (without using a vibrator or inefficient rotary convertor) to obtain 200 volts for B-supply. The circuit of Fig. 3 can be used for 117 volts, a.c. or 110 volts d.c., but the amplifier output will be reduced to 10 watts as the B-plus voltage will be slightly lower than line voltage.

To delay application of the B-plus voltage, a switch (*S1-a*, Fig. 4) is included in the supply to the output tubes and is closed about one minute after the main switch. The disadvantage here is the possible failure of the human element in forgetting to make sure that this switch is off, before applying line voltage to the B-supply. A foolproof but more expensive solution would be to use a thermal time delay relay.

Surge prevention

During the initial testing a serious snag was apparent; no line dropping resistance was included for the heaters as the tubes employed required 118 volts. When switched on, the initial current surge was very high (about .5 amp) and two of the output tubes lit up very brightly!

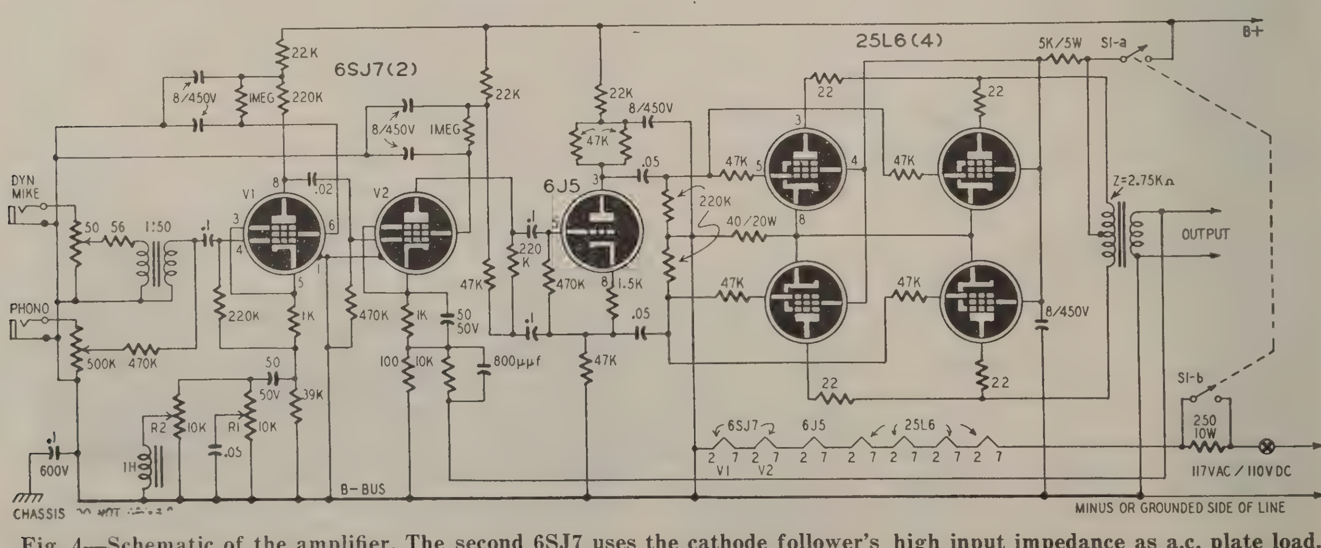


Fig. 4—Schematic of the amplifier. The second 6SJ7 uses the cathode follower's high input impedance as a.c. plate load.

It is possible to use a Globar resistor or thermistor to limit the surge. This would cause a drop of only a few volts. However, since this amplifier was to be used for at least 50% of its time on d.c. lines whose voltage is slightly lower than a.c. lines, it was felt that as little voltage as possible should be lost. Consequently, the surge is limited by including in the heater chain a 250-ohm resistor which is short-circuited by one side of a double-pole on-off switch (*S1-b*, Fig. 4); the other side is used for the B-supply delay.

Amplifier construction

A complete schematic of the amplifier is given in Fig. 4; the tone-control and phase-splitter circuits are exactly the same as in the a.c. version previously published. Grid stoppers (50,000-ohm resistors) are included for each of the four output tubes to prevent push-pull oscillation at high frequencies, and small plate resistors (22 ohms) are included for the same reason. These resistors should be mounted as near the sockets of the tubes as possible. For stable operation with 20 db feedback, it was necessary to put a small (800 μμf) capacitor across the feedback resistor. Other setups might need slightly different values.

Construction of this amplifier presents no really difficult problems. Take the usual precautions to minimize hum, and make no attempt to pack the components into the smallest possible space.

Adequate ventilation is important as far as the output tubes are concerned because they get very hot. They should be well separated.

The amplifier is straightforward and if instructions are followed no "bugs" should be encountered. The phase-inverting circuit is stable, and consists of the 6SJ7 and the 6J5. The 6SJ7 is operated so that the stage gain approaches the amplification factor of the tube. This is achieved by making the plate load of the tube the extremely high input impedance of a cathode-follower phase splitter. For additional consideration of this point and the action of the bass-boost control, R2, and the treble boost, R1, refer to the previous article which appears on page 45 of the September, 1950, issue.

Materials for amplifier

Resistors: 4—22, 1—50, 1—56, 1—100, 1—1,000, 1—1,500, 1—10,000, 3—22,000, 1—39,000, 7—47,000, 4—220,000, 2—470,000 ohms; 2—1 megohm, ½ watt. (Potentiometers) 1—50, 2—10,000, 1—500,000 ohms; 1—5,000 ohms, 5 watts; 1—40 ohms, 20 watts; 1—250 ohms, 10 watts.
Capacitors: (Paper) 1—.0008, 1—.02, 3—.05, 2—0.1 μf, 450 volts. (Electrolytic) 5—8 μf, 450 volts; 2—50 μf, 450 volts; 2—50 μf, 50 volts.
Inductors: 1—Output transformer, primary impedance 2,750 ohms, 10-20 watts output rating. 1—Input transformer for dynamic mike.
Miscellaneous: Tubes: 2—6SJ7, 1—6J5, 4—25L6. Tube sockets. 1—Double-pole, single-throw switch. Mike jack. Phone jack. Output binding posts. Insulating washers. Lock washers. Chassis. Hardware. Hookup wire.

Power Supplies (Choose (a) or (b))

(a) Chokes: 2—20 h, 150 ma. Selenium rectifiers: 2—200 ma. Capacitors, electrolytic: 2—25 μf, 450 volts; 1—50 μf, 450 volts. Capacitor, paper: 1—.01 μf, 1,000 volts. Resistor: 1—5.6 ohms, 2 watts.
(b) Choke: 1—10 h, 250 ma. Selenium rectifiers: 2—200 ma. Capacitors, electrolytic: 2—100 μf, 250 volts; 1—50 μf, 350 bolts. Resistors: 2—10 ohms, 2 watts.

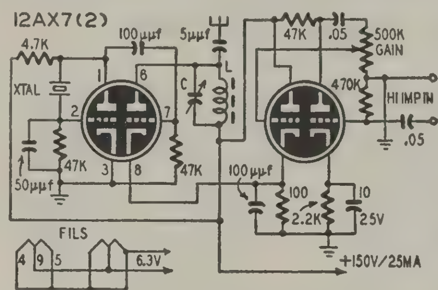
—end—

Phono Oscillator Uses Crystal

Features of this simple phono oscillator are crystal control, a high level of modulation, excellent fidelity, and a minimum of parts. Two 12AX7's were used in the original circuit, but 12SN7's, 12AY7's, 12SL7's, and other similar double triodes can be used.

One section of the first tube is a Pierce crystal oscillator and the other section is a cathode-modulated r.f. amplifier. The second tube is connected as a high-gain speech amplifier and a cathode-follower type series modulator. The cathodes of the modulator and r.f. amplifier tubes are returned to ground through a 100-ohm resistor bypassed for r.f. but not for audio. The power amplifier is modulated by the a.f. voltage drop across the cathode resistor.

The crystal may be cut to the fundamental or subharmonic of the desired broadcast frequency. Surplus crystals ranging from approximately 310 to 500 kc are available from some sources for less than 50 cents each. These can be used for the broadcast band by adjusting the tuned circuit to the desired harmonic. The coil L may be the secondary of a broadcast antenna coil. The tuning capacitor C may be a trimmer of approximately 400 μμf maximum capacitance.—*John S. Hill*



Audio Phase-Shift Measurements

Phase angle between two a.f. voltages is usually measured on a Z-angle meter or by measuring the tilt of an elliptical pattern on an oscilloscope. The first method is expensive for those who rarely have need for such instruments. The latter method does not permit precise measurements. Writing in *Electronics*, L. Fleming describes two inexpensive devices which simplify the problem of measuring phase angle on an oscilloscope.

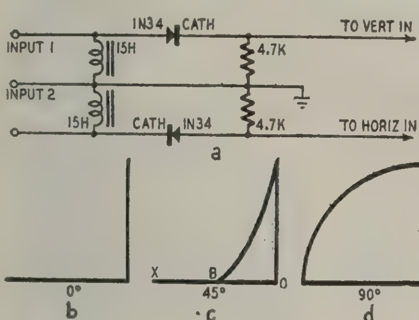


Fig. 1—Clippers provide voltages for comparing phase of two audio signals.

The circuit of the first device is shown at *a* in Fig. 1. Two 1N34 rectifiers are connected so as to clip the positive half-cycle of one signal and the negative half-cycle on the other. When the phase angle is 0, an L-shaped pattern is produced as at *b*. When the angle is between 0 and 90°, the pattern looks like a shelf bracket as shown at *c*. This pattern is produced because of the difference in trace and retrace paths of the beam. The sine of the phase angle is the intercept distance OB divided by the base distance OX. A pattern for a phase angle of 90° is shown at *d*. Above 90°, the legs of the L are foreshortened and measurements are difficult. This circuit will not distinguish between lag and lead. Its usefulness is confined to measurements less than approximately 60°. The d.c. resistance on the input side of the rectifiers should be low compared to the load resistance to insure clipping at the zero line.

The second circuit is shown at *a* in Fig. 2. One of the signals is differentiated into sharp positive pips which are superimposed on the sine wave of the other. The position of the pip is determined by the phase angle. Pips are shown on the sine wave at *b* in the positions they would occupy with phase angles of 0, 90, 180, and 270°.

The top frequency for this circuit is approximately 3 kc because of the difficulty in obtaining sharp pips with this circuit. The differentiators—the .001- and .002-μf capacitors and 10,000-ohm resistors—have time constants usable over a frequency range of approximately 2 to 1. Values shown are suitable for 250 to 500 cycles. For other ranges, the values of the capacitors should be varied accordingly.

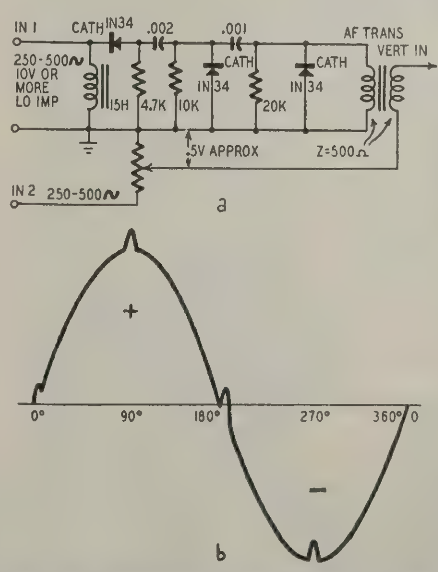
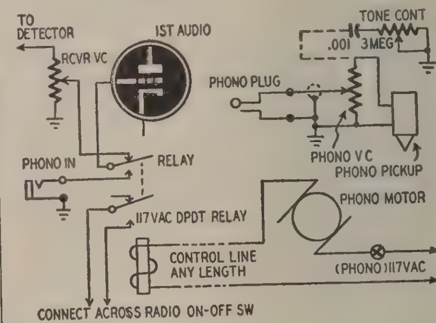


Fig. 2—Easier to read, this circuit has wider range than circuit in Fig. 1.

REMOTE PHONO CONTROL

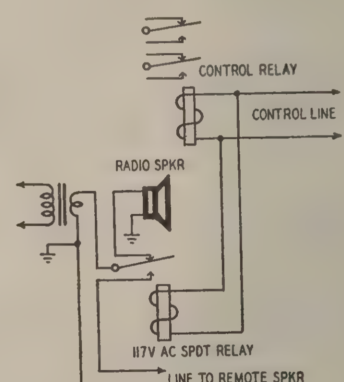
The remote-control circuit shown in *a* turns on a radio and switches it to phono without any controls on the radio set being touched. A midget d.p.d.t. relay is used, for instance the Leach, model 327, 110 volt, a.c. unit. One set of contacts shunts the radio on-off switch. The other set of contacts disconnects the receiver's audio amplifier from the detector output and connects it to the phono input jack. The



a

relay closes when the phono motor is turned on. A control line of lamp cord is run from the phono to the radio, and a shielded lead connects the pickup with the phono input jack on the receiver. Volume is controlled directly from the record player. Turning off the phonograph restores normal radio operation.

Any location on the radio chassis is suitable for the relay. Keep the leads going to the volume control and phono



b

input jack well shielded. The relay coil and radio power switch leads should be isolated from the audio circuit and twisted to prevent stray hum pickup. The phono unit may be located up to 25 feet from the radio. It is important to use shielded mike cable to the radio, and the phonograph output should be reasonably high.

Tone can also be controlled at a distance from the radio set by using the high-frequency attenuation circuit shown in dotted lines in the diagram. In this case adjust the radio tone control beforehand to the maximum treble position.

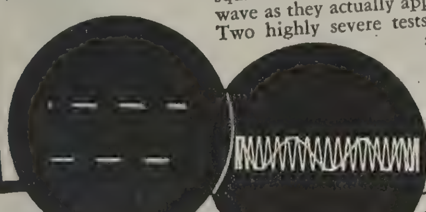
Circuit *b* shows how to switch on an extension speaker while using phono by wiring another relay in parallel with the radio-phono control relay.

—end—

Features OF THE NEW 1952 Heathkits

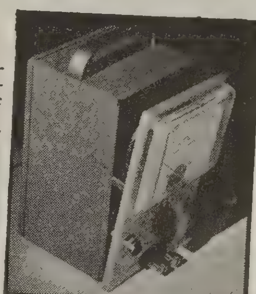
PROOF OF THE NEW O-7 OSCILLOSCOPE'S OUTSTANDING PERFORMANCE

Below are actual, unretouched photographs showing the outstanding frequency response characteristics of the NEW 1952 HEATHKIT OSCILLOSCOPE MODEL O-7. To the left is a 10 KC square wave — to the right a 4 MC sine wave as they actually appear on the screen. Two highly severe tests to make on any scope (only the best of scopes will show traces like these) — and the O-7 really comes through.



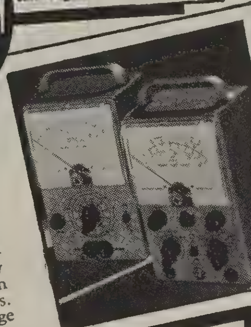
NEW STYLE AND BEAUTY

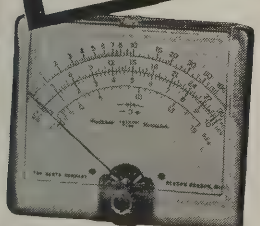
Style that's modern, yet functional — that's the trend of today — and Heathkits are right up to the minute. Note the cut showing the new V-5 and AV-1 cabinet and panel construction. The front panel and rear cover slide right over the recessed flange of the case thereby eliminating sharp edges and pointed corners. The voltmeter kits aren't "shelf" or "mounted" instruments — they're moved about on the bench a lot and thus the new compact size and specially designed cabinets — Another 1952 Heathkit feature.



COMPANION VACUUM TUBE VOLTMETERS

Here are the two NEW 1952 VACUUM TUBE VOLTMETER COMPANION PIECES. Matched instruments of new design to open up the whole field of DC, AC, and resistance measurements for you. The new greatly reduced size combines style, beauty, and compactness — The V-5 and AV-1 have the new panel and cabinet construction as shown on the right. A tremendous pair of voltmeters. Small in size but virtual giants in the range of measurements they make.





A STATEMENT FROM SIMPSON ELECTRIC CO.

In choosing Simpson Meters for their Heathkit VTVM, the Heath Co. has set a new high standard of kit meter quality. The same high quality of material, workmanship and design that has given Simpson the reputation for building "Instruments That Stay Accurate" is found in the Heathkit Meter Movement.

SIGNED
SIMPSON ELECTRIC CO.

A STATEMENT FROM CHICAGO TRANSFORMER

It is indeed gratifying to note the outstanding sales records you are building with your Heathkits.

This sales success is readily understandable, since we are cognizant of the high quality standards you have established for your component suppliers.

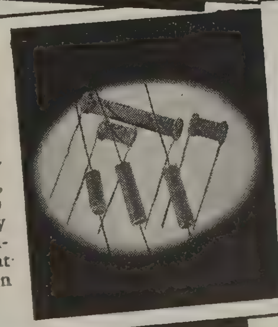
We at Chicago Transformer are proud that our product has contributed to the recognized quality and increasing popularity of Heathkits.

CHICAGO TRANSFORMER DIVISION
Essex Wire Corporation

L. S. RACINE
Vice-President and Sales Manager

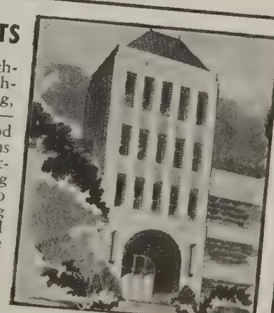
HEATHKIT PRECISION RESISTORS

Where exact resistance values are required for instrument accuracy, the Heath Co. has spared no effort in supplying the finest resistors available. Precision resistors as manufactured by Continental Carbon Inc., and Wilcor Corp., meet the rigorous JAN (Joint Army-Navy) specifications and are small in size, extremely non-inductive, highly stable, have a low temperature coefficient, and can be held to great accuracy. You'll find quality components in Heathkits.



COLLEGES USE HEATHKITS

Colleges and Universities throughout the country are using Heathkits in their electrical engineering, radio, and physics laboratories — Heathkits are the answer to good test equipment at low cost, plus being rugged, dependable, and accurate. Trade schools are having their students build Heathkits to obtain a first hand working knowledge of test equipment and to get the practical experience gained by construction. Heathkits fill school needs.



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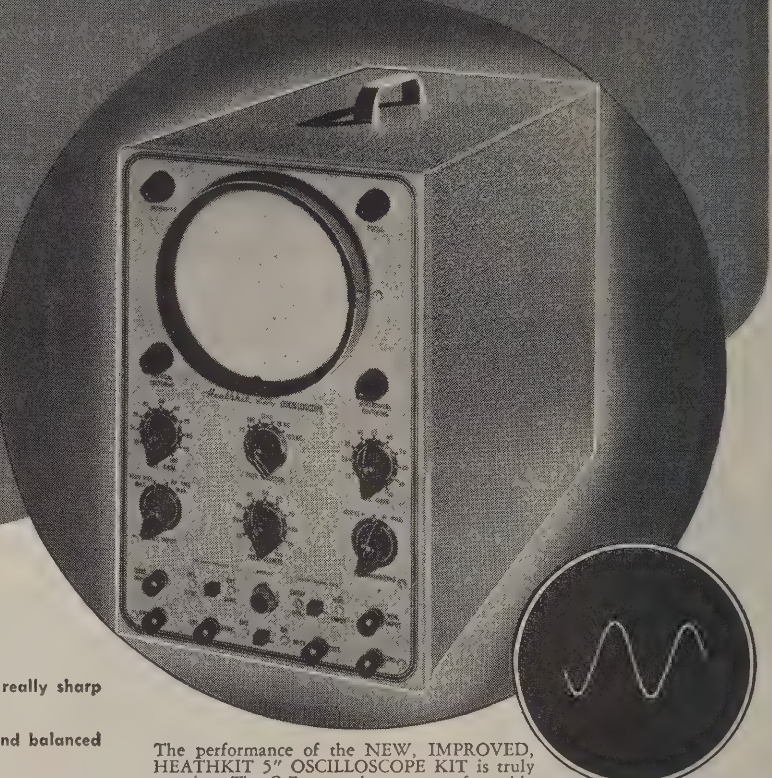
THE *New* 1952 *Heathkit* OSCILLOSCOPE KIT

MODEL O-7
SHIPPING WEIGHT 24 LBS.

$43.50



Features

- New "spot shape" control for spot adjustment — to give really sharp focusing.
- A total of ten tubes including CR tube and five miniatures.
- Cascaded vertical amplifiers followed by phase splitter and balanced push-pull deflection amplifiers.
- Greatly reduced retrace time.
- Step attenuated — frequency compensated — cathode follower vertical input.
- Low impedance vertical gain control for minimum distortion.
- New mounting of phase splitter and deflection amplifier tubes near CR tube base.
- Greatly simplified wiring layout.
- Increased frequency response — useful to 5 Mc.
- Tremendous sensitivity .03V RMS per inch Vertical — .6V RMS per inch Horizontal.
- Dual control in vernier sweep frequency circuit — smoother acting.
- Positive or negative peak internal synchronization.

The performance of the NEW, IMPROVED, HEATHKIT 5" OSCILLOSCOPE KIT is truly amazing. The O-7 not only compares favorably with equipment costing 4 and 5 times as much, but in many cases literally surpasses the really expensive equipment. The new, and carefully engineered circuit incorporates the best in electronic design — and a multitude of excellent features all contribute to the outstanding performance of the new scope.

The VERTICAL CHANNEL has a step attenuated, frequency compensated vertical input which feeds a cathode follower stage — this accomplishes improved frequency response, presents a high impedance input, and places the vertical gain control in a low impedance circuit for minimum distortion. Following the cathode follower stage is a twin triode — cascaded amplifiers to contribute to the scope's extremely high sensitivity. Next comes a phase splitter stage which properly drives the push-pull, hi-gain, deflection amplifiers (whose plates are directly coupled to the vertical deflection plates). This fine tube lineup and circuitry give a sensitivity of .03V per inch RMS vertical and useful frequency response to 5 Mc.

The HORIZONTAL CHANNEL consists of a triode phase splitter with a dual potentiometer (horizontal gain control) in its plate and cathode circuits for smooth, proper driving of the push-pull horizontal deflection amplifiers. As in the vertical channel, horizontal deflection amplifier plates are direct coupled to the CR tube horizontal deflection plates (for improved frequency response).

The WIDE-RANGE SWEEP GENERATOR circuit incorporates a twin triode multivibrator stage for producing a good saw-tooth sweep frequency (with faster retrace time). Has both coarse and vernier sweep frequency controls.

And the scope has internal synchronization which operates on either positive or negative peaks of the input signal — both high and low voltage rectifiers — Z axis modulation (intensity modulation) — new spot shape (astigmatism) control for spot adjustment — provisions for external synchronization — vertical centering and horizontal centering controls, wide range focus control — and an intensity control for giving plenty of trace brilliance.

The Model O-7 EVEN HAS GREAT NEW MECHANICAL FEATURES — A special extra-wide CR tube mounting bracket is provided so that the vertical cascade amplifier, vertical phase splitter, vertical deflection amplifier, and horizontal deflection amplifier can mount near the base of the CR tube. This permits close connection between the above stages and to the deflection plates; distributed wiring capacity is greatly reduced, thereby affording increased high frequency response.

The power transformer is specially designed so as to keep its electrostatic and electromagnetic fields to a minimum — also has an internal shield with external ground lead.

You'll like the complete instructions showing all details for easily building the kit — includes pictorials, step-by-step construction procedure, numerous sketches, schematic, circuit description. All necessary components included — transformer, cabinet, all tubes (including CR tube), completely punched and formed chassis—nothing else to buy.

NEW INEXPENSIVE *Heathkit* ELECTRONIC SWITCH KIT

The companion piece to a scope — Feed two different signals into the switch, connect its output to a scope, and you can observe both signals — each as an individual trace. Gain of each input is easily set (gain A and gain B controls), the switching frequency is simple to adjust (coarse and fine frequency controls) and the traces can be superimposed for comparison or separated for individual study (position control).

Use the switch to see distortion, phase shift, clipping due to improper bias, both the input and output traces of an amplifier — as a square wave generator over limited range.

The kit is complete; all tubes, switches, cabinet, power transformer and all other parts, plus a clear detailed construction manual.

Model S-2
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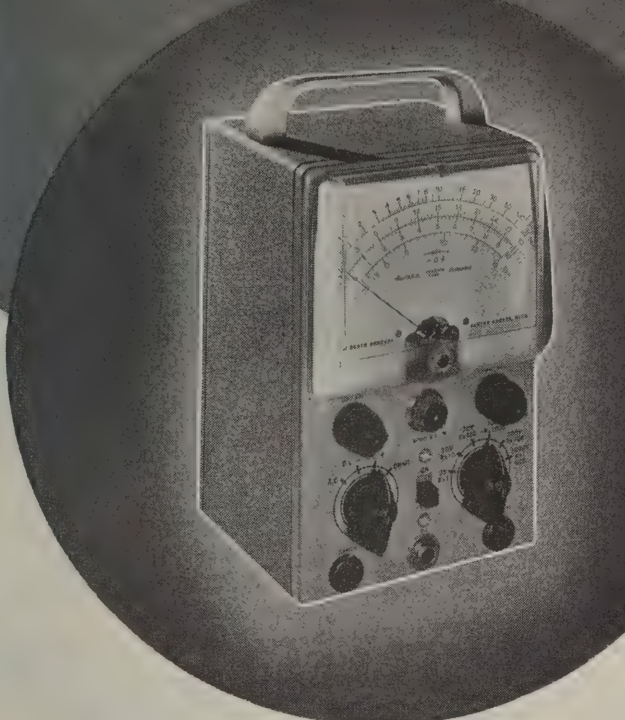


THE *New* 1952 *Heathkit* VTVM KIT

MODEL V-5
SHIPPING WT. 5 LBS.

$24.50

Features

- New styling, — formed case for beauty.
- New truly compact size. Cabinet 4⅛" deep by 4-11/16" wide by 7⅜" high.
- Quality 200 microamp meter.
- New ohms battery holding clamp and spring clip — assurance of good electrical contact.
- Highest quality precision resistors in multiplier circuit.
- Calibrates on both AC and DC for maximum accuracy.
- Terrific coverage — reads from ½V to 1000V AC, ½V to 1000V DC, and .1 to over 1 billion ohms resistance.
- Large, clearly marked meter scales indicate ohms, AC Volts, DC Volts, and DB — has zero set mark for FM alignment.
- New styling presents attractive and professional appearance.

A real beauty — you'll have only highest praise for this NEW MODEL VACUUM TUBE VOLTMETER. Truly a beautiful little instrument — and it's more compact than any of our previous models. Note the new rounded edges on the front panel and rear cover. The size is greatly reduced to occupy a minimum of space on your workbench — yet the meter remains the same large size with plainly marked scales.

A set of specially designed control mounting brackets permit calibration to be performed with greatest ease — also makes for ease in wiring. New battery mounting clamp holds ohms battery tightly into place, and base spring clip insures a good connection to the ohms string of resistors.

The circuitry employs two vacuum tubes — A duo diode operating when AC voltage measurements are taken, and a twin triode in the circuit at all times. The cathode balancing circuit of the twin triode assures sensitive measurements, and yet offers complete protection to the meter movement. Makes the meter burn-out proof in a properly constructed instrument.

Quality components are used throughout —1% precision resistors in the multiplier circuit—conservatively rated power transformer—Simpson meter movement — excellent positive detent, smooth acting switches — sturdy cabinet, etc.

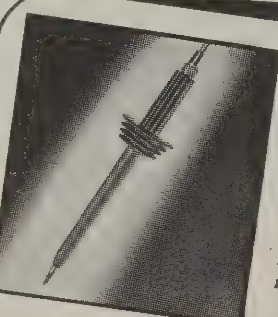
And you can make a tremendous range of measurements — ½V to 1000V AC, ½V to 1000V DC, .1 to over 1 billion ohms, and DB. Has mid-scale zero level marking for quick FM alignment. DB scale in red for easy identification — all other scales a sharp, crisp black for for easy reading.

A four position selector switch allows operator to rapidly set the instrument for type or reading desired—positions include ACV, DC+V, DC—V, and Ohms. DC— position allows negative voltage to be rapidly taken. Zero adjust and ohms adjust controls are conveniently located on front panel.

Enjoy the numerous advantages of using a VTVM. Its high input impedance doesn't "load" circuits under test — therefore, assures more accurate and dependable readings in high impedance circuits such as resistance coupled amplifiers, AVC circuits, etc. Note the 30,000 VDC probe kit and the RF probe kit — available at low extra cost and specially designed for use with this instrument. With these two probes, you can make DC voltage measurements up to 30,000V, or make RF measurements — added usefulness to an already highly useful instrument.

The instruction manual is absolutely complete — contains a host of figures, pictorials, schematic, detailed step-by-step instructions, and circuit description. These clear, detailed instructions make assembly a cinch.

And every part is included — meter, all controls, pilot light, switches, test leads, cabinet, instruction manual, etc.



Heathkit 30,000V DC PROBE KIT

A new 30,000 V DC Probe Kit to handle high voltages with safety. For TV service work and all other high voltage applications. Sleek looking — Two color molded plastic — Red body and guard — jet black handle. Comes with connector, cable, and PL55 type plug. Plugs into Heathkit VTVM so that 300V scale is conveniently multiplied by 100. Can be used with any standard 11 megohm VTVM.

$5.50

No. 336 High Voltage Probe Kit
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Heathkit RF PROBE KIT

This RF Probe Kit comes complete with probe housing, crystal diode detector, connector, lead and plug and all other parts plus clear assembly instructions. Extends range of Heathkit VTVM to 250 Mc. ± 10%. Works on any 11 megohm input VTVM. Specify No. 309 RF Probe Kit.

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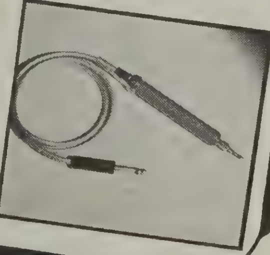
Ship. Wt. 1 lb.



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SIGNAL GENERATOR KIT

Model SG-6
Shipping Wt. 7 lbs.

The new Heathkit Signal Generator Kit has dozens of improvements. Covers the extended range of 160 Kc to 50 megacycles on fundamentals and up to 150 megacycles on useful calibrated harmonics; makes this Heathkit ideal as a marker oscillator for TV. Output level can be conveniently set by means of both step attenuator and continuously variable output controls. Instrument has new miniature HF tubes to easily handle the high frequencies covered.

Uses 6C4 master oscillator and 6C4 sine wave audio oscillator. The kit is transformer operated and a husky selenium rectifier is used in the power supply. All coils are precision wound and checked for calibration making only one adjustment necessary for all bands.

New sine wave audio oscillator provides internal modulation and is also available for external audio testing. Switch provided allows the oscillator to be modulated by an external audio oscillator for fidelity testing of receivers. Comes complete, all tubes, cabinet, test leads, every part. The instruction manual has step-by-step instructions and pictorials. It's easy and fun to build a Heathkit Model SG-6 Signal Generator.

$19.50

Heathkit

CONDENSER CHECKER KIT

Only

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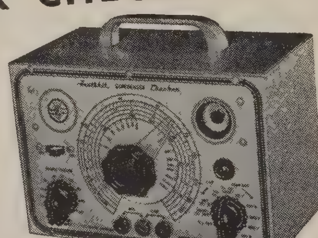


Model C-2
Shipping Wt. 6 lbs.

Checks all types of condensers — paper — mica — ceramic — electrolytic. All condenser scales are direct reading and require no charts or multipliers. Covers range of .00001 MFD to 1000 MFD. A Condenser Checker that anyone can read. A leakage test and polarizing voltage for 20 to 500 V provided. Measures power factor of electrolytics between 0% and 50% and reads resistance from 100 ohms to 5 megohms. The magic eye indicator makes testing easy.

The kit is 110V 60 cycle transformer operated and comes complete with rectifier tube, magic eye tube, cabinet, calibrated panel and all other parts. Has clear detailed instructions for assembly and use.

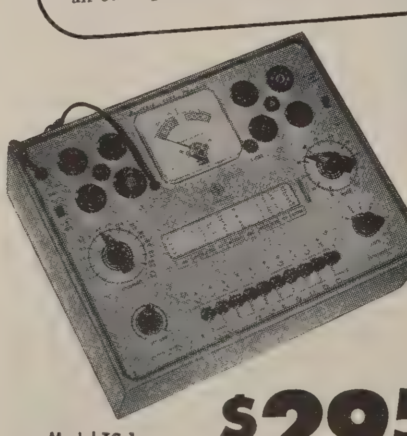
NEW *Heathkit*

SIGNAL TRACER AND UNIVERSAL TEST SPEAKER KIT

$19.50

Model T-2
Shipping Wt. 7 lbs.

The popular Heathkit Signal Tracer has now been combined with a universal test speaker at no increase in price. The same high quality tracer follows signal from antenna to speaker — locates intermittents — finds defective parts quicker — saves valuable service time — gives greater income per service hour. Works equally well on broadcast, FM, or TV receivers. The test speaker has an assortment of switching ranges to match either push-pull or single output impedances. Also tests microphones, pickups and PA systems. Comes complete: cabinet, 110V 60 cycle power transformer, tubes, test probe, all necessary parts, and detailed instructions for assembly and use.



Heathkit

TUBE CHECKER KIT

The Tube Checker is a MUST for radio repair men. Often customers want to SEE tubes checked, and a checker like this builds customer confidence. In your repairing, you will have a multitude of tubes to check — quickly. The Heathkit tube checker will serve all these functions — it's good looking (with a polished birch cabinet and an attractive two color panel) — checks 4, 5, 6, 7 prong Octals, Loctals, 7 prong miniatures, 9 prong miniatures, pilot lights, and the Hytron 5 prong types. AND IT'S FAST TO OPERATE — the gear driven, free-running roll chart lists hundreds of tubes, and the smooth acting, simplified switching arrangement gives really rapid set-ups.

The testing arrangement is designed so that you will be able to test new tubes of the future — without even waiting for factory data — protection against obsolescence.

You can give tubes a thorough testing — checks for opens, shorts, each element individually, emission, and for filament continuity. A large BAD-?-GOOD meter scale is in three colors for easy reading and also has a "line-set" mark.

You'll find this tube checker kit a good investment — and it's only $29.50.

Model TC-1
Shipping Wt. 12 lbs.

$29.50

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. . . BENTON HARBOR 20, MICHIGAN

New LABORATORY LINE HEATHKITS

NEW *Heathkit* A.C. VACUUM TUBE VOLTMETER KIT

Now — as a Heathkit — at a price anyone can afford, an AC VTVM.
A new kit to make possible those sensitive AC measurements required by audio enthusiasts, laboratories, and experimentors. Here is the kit that the audio men have been looking for. Its tremendous range of coverage makes possible measurements of audio amplifier frequency response — gain or loss of audio stages — characteristics of audio filters and attenuators — hum investigation — and literally a multitude of others. Ten ranges consisting of full scale .01, .03, .1, .3, 1, 3, 10, 30, 100, 300 volts RMS assure easy and more accurate readings. Ten ranges on DB provide for measurements from −52 to +52 DB. Frequency response within 1 DB from 20 cycles to 50 KC.

The ingenious circuitry incorporates precision multiplier resistors for accuracy, two amplifier stages using miniature tubes, a unique bridge rectifier meter circuit, quality Simpson meter with 200 microampere movement, and a clean layout of parts for easy wiring. A high degree of inverse feedback provides for stability and linearity.

Simple operation is accomplished by the use of only one control, a range switch which changes the voltage ranges in multiples of 1 and 3, and DB ranges in steps of 10.

The instrument is extremely compact, cabinet size — 4⅛" deep x 4-11/16" wide x 7⅜" high, and the newly designed cabinet makes this the companion piece to the VTVM. For audio work, this kit is a natural.

MODEL AV-1
Shipping weight 5 lbs.

$29.50

NEW *Heathkit* AUDIO FREQUENCY METER KIT

MODEL AF-1
Shipping weight 12 lbs.

$34.50

A NEW Heathkit Audio Frequency Meter — the ideal instrument for determining frequencies from 20 cycles to 100 KC. Set the selector switch to the proper range — feed the signal into the input terminals — and read the frequency from the meter — completely simple to operate, and yet dependable results.

Quality Simpson 200 microampere meter has two plainly marked scales (0-100 0-300. These scales, read in conjunction with the seven position selector switch, give full scale readings of 100, 300, 1000, 3000, 10,000, 30,000, and 100,000 cycles. Convenient ranges for fast and easy readings.

For greatest accuracy, the 1-3-10 ratio of ranges is maintained and each range has individual calibrating control.

Input impedance is high (1 megohm) for negligible circuit loading. A signal voltage anywhere between 2 and 300V can be fed directly into the instrument and a change in signal voltage between these limits will not affect the meter reading. In addition, input wave shape is not critical (the unit will read the frequency of either sine wave or square wave input).

The tube complement consists of a 6SJ7 amplifier and clipper, 6V6 amplifier and clipper, 6H6 meter pulse rectifier, 6X5 power supply rectifier, and OD3/VR150 voltage regulator.

Construction is simple, and quality components are used throughout.

NEW *Heathkit* INTERMODULATION ANALYZER KIT

Intermodulation testing of audio equipment is rapidly being accepted by more and more engineers and audio experts as the best way to determine the characteristics of audio amplifiers, recording systems, networks, etc. — shows up those undesirable characteristics which contribute to listening fatigue when all other methods fail.

The Heathkit Intermodulation Analyzer supplies a choice of two high frequencies (3000 cycles and a higher frequency) and one low frequency (60 cycles). Both 1:1 or 4:1 ratios of low to high frequencies can be set up for IM testing, and the ratios are easily set by means of a panel control and the instrument's own VTVM. An output level control supplies the mixed signal at the desired level with an output impedance of two thousand ohms. The Analyzer section has input level control and proper filter circuits feeding the instrument's VTVM to read intermodulation directly on full scale ranges of 30%, 10% and 3%. Built-in power supply furnishes all necessary voltages for operating the instrument.

You won't want to be without this new and efficient means of testing

MODEL IM-1
Shipping wt. 18 lbs.

$39.50

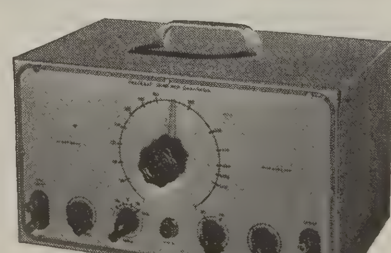
NEW *Heathkit* SQUARE WAVE GENERATOR KIT

The new Heathkit Square Wave Generator Kit with its 100 KC square wave opens an entirely new field of audio testing. Square wave testing over this wide range will quickly show high and low frequency response characteristics of circuits — permit easy adjustment of high frequency compensating networks used in vidio amplifiers — identify ringing in circuits — demonstrate transformer characteristics, etc.

The circuitry consists of a multivibrator stage, a clipping and squaring stage, and a cathode follower output stage. The power supply is transformer operated and utilizes a full wave rectifier tube with 2 sections of LC filtering.

As a multivibrator cannot be accurately calibrated, a provision is provided to allow the instrument to be accurately synchronized with an accurate external source when extreme accuracy is required.

The low impedance output is continuously variable between 0 and 25 volts and operation is simple. You'll really appreciate the wide range of this instrument, 10 cycles to 100 kilocycles — continuously variable. Kit is complete with all parts and instruction manual, and is easy to build.



MODEL SQ-1
Shipping wt. 14 lbs.

$29.50

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IMPEDANCE BRIDGE KIT

Model 1B-1B
Shipping Wt. 15 lbs.

$69.50

This Impedance Bridge Kit is really a favorite with schools, industrial laboratories, and serious experimenters. An invaluable instrument for those doing electrical measurements work. Reads resistance from .01 Ohms to 10 meg., capacitance from .00001 to 100 MFD, inductance from 10 microhenries to 100 henries, dissipation factor from .002 to 1, and storage factor from 1 to 1000. And you don't have to worry about selecting the proper bridge circuit for the various measurements — the instrument automatically makes the correct circuit when you set up for taking the measurement you want. Bridge utilizes Wheatstone, Hay, Maxwell, and capacitance comparison circuits for the wide range and types of measurements possible. And it's self powered — has internal battery and 1000 cycle hummer. No external generator required — has provisions for external generator if measurements at other than 1000 cycles are desired. Kit utilizes only highest quality parts, General Radio main calibrated control. Mallory ceramic switches, excellent 200 microamp zero center galvanometer, laboratory type binding posts with standard ¾ inch centers, 1% precision ceramic-body type multiplier resistors, beautiful birch cabinet and ready calibrated panel. (Headphones not included.)

Take the guesswork out of electrical measurements — order your Heathkit Impedance Bridge kit today — you'll like it.

Heathkit LABORATORY

RESISTANCE DECADE KIT

$19.50

Shipping Wt. 4 lbs.

An indispensable piece of laboratory equipment — the Heathkit Resistance Decade Kit gives you resistance settings from 1 to 99,999 ohms IN ONE OHM STEPS. For greatest accuracy, 1% precision ceramic-body type resistors and highest quality ceramic wafer switches are used.

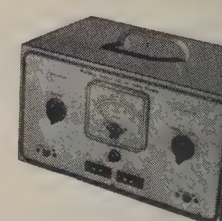
Designed to match the Impedance Bridge above, the Resistance Decade Kit has a beautiful birch cabinet and attractive panel. It's easy to build, and comes complete with all parts and construction manual.

Heathkit LABORATORY

POWER SUPPLY KITS

Limits:

No load..........................**Variable 150-400V DC**
25 MA..........................**Variable 30-310V DC**
50 MA..........................**Variable 25-250V DC**
Higher loads: Voltage drops off proportionally



$29.50

Model PS-1.....Ship. Wt. 20 lbs.

Every experimenter needs a good power supply for electronic setups of all kinds. This unit has been expressly designed to act as a HV supply and a 6.3 V filament voltage source. Voltage control allows selection of HV output desired (continuously variable within limits outlined), and a Volts-Ma switch provides choice of output metering. A large plainly marked and direct reading meter scale indicates either DC voltage output in Volts or DC current output in Ma. (Range of meter 0-500V D.C., 0-200 Ma. D.C.). Instrument has convenient stand-by position and pilot light.

Comes with power transformer, filament transformer, meter, 5Y3 rectifier, two 1619 control tubes, completely punched and formed chassis, panel, cabinet, detailed construction manual, and all other parts to make the kit complete.

Heathkit

ECONOMY . . . 6 WATT

AMPLIFIER KIT

Model A-4
Ship. Wt. 8 lbs.

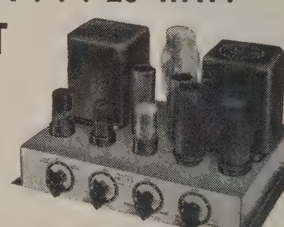
$12.50

No. 304 12 inch speaker . . . $6.95

This fine Heathkit Amplifier was designed to give quality reproduction and yet remain low in price. Has two preamp stages, phase inverter stage, and push-pull beam power output. Comes complete with six tubes, quality output transformer (to 3-4 ohm voice coil), husky cased power transformer and all other parts. Has tone and volume controls. Instruction manual has pictorial for easy assembly. Six watts output with response flat ± 1½ db from 50 to 15,000 cycles. A quality amplifier kit at a low price. Better build one.

Heathkit HIGH FIDELITY . . . 20 WATT

AMPLIFIER KIT



$33.50

Shipping Wt. 18 lbs.

Our latest and finest amplifier — the model A-6 (or A-6A) is capable of a full 20 Watts of high fidelity output — good faithful reproduction made possible through careful circuit design and the use of only highest quality components. Frequency response within ± 1 db from 20-20,000 cycles. Distortion at 3 db below maximum power output (at 1000 cycles) is only .8%. The power transformer is rugged and conservatively rated and will deliver full plate and filament supply with ease. The output transformer was selected because of its exceptionally good frequency response and wide range of output impedances (4-8-16-150-600 ohms). Both are Chicago Transformers in drawn steel case for shielding and maximum protection to windings. The unit has dual tone controls to set the output for the tonal quality desired — treble control attenuates up to 15 db at 10,000 cycles — bass control gives bass boost up to 10 db at 50 cycles.

Tube complement consists of 5U4G rectifier, 6SJ7 voltage amplifier, 6SN7 amplifier and phase splitter, and two 6L6's in push-pull output. Comes complete with all parts and detailed construction manual. (Speaker not included.)

MODEL A-6: For tuner and crystal phono inputs. Has two position selector switch for convenient switching to type of input desired.

MODEL A-6A: Features an added 6SJ7 stage (preamplifier) for operating from variable reluctance cartridge phono pickup, mike input, and either tuner or standard crystal phono pickup. A three position selector switch provides flexible switching. **$35.50**
Shipping Wt. 18 lbs.

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Heathkit RECEIVER & TUNER KITS for AM and FM

$19.50

Model BR-1 Broadcast Model Kit covers 550 to 1600 Kc. Shipping Wt. 10 lbs.

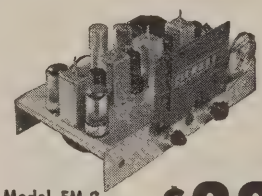
Model AR-1 3 Band Receiver Kit covers 550 Kc. to over 20 Mc. continuous. Extremely high sensitivity. Shipping Wt. 10 lbs.

$23.50

TWO HIGH QUALITY Heathkit SUPERHETRODYNE RECEIVER KITS

Two excellent Heathkits. Ideal for schools, replacement of worn out receivers, amateur and custom installations.

Both are transformer operated quality units. The best of materials used throughout — six inch calibrated slide rule dial — quality power output transformers — dual iron core shielded. I.F. coils — metal cased filter condenser. The chassis has phono input jacks, 110 Volt output for phono motor and there is a phono-radio switch on panel. A large metal panel simplifying installation in used console cabinets is included. Comes complete with tubes and instruction manual incorporating pictorials and step-by-step instructions (less speaker and cabinet). The three band model has simple coil turret which is assembled separately for ease of construction.



Model FM-2
Ship. Wt. 9 lbs.

$22.50

TRUE FM FROM Heathkit FM TUNER KIT

The Heathkit FM Tuner Model FM-2 was designed for best tonal reproduction. The circuit incorporates the most desirable FM features — true FM.

Utilizes 8 tubes: 7E5 Oscillator, 6SH7 mixer, two 6SH7 IF amplifiers, 6SH7 limiter, two 7C4 diodes as discriminator, and 6X5 rectifier.

The instrument is transformer operated making it safe for connection to any type receiver or amplifier. Has ready wound and adjusted RF coils, and 2 stages of 10.7 Mc IF (including limiter). A calibrated six inch slide rule dial has vernier drive for easy tuning. All parts and complete construction manual furnished.

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Quantity	Item	Price	Quantity	Item	Price
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	Heathkit VTVM Kit — Model V-5			Heathkit R.F. Signal Gen. Kit — Model SG-6	
	Heathkit FM Tuner Kit — FM-2			Heathkit Condenser Checker Kit — Model C-2	
	Heathkit Broadcast Receiver Kit — Model BR-1			Heathkit Handitester Kit — Model M-1	
	Heathkit Three Band Receiver Kit—Model AR-1			Heathkit Power Supply Kit — Model PS-1	
	Heathkit Amplifier Kit — Model A-4			Heathkit Resistance Decade Kit — Model RD-1	
	Heathkit Amplifier Kit — Model A-6 (or A-6A)			Heathkit Impedance Bridge Kit — Model IB-1B	
	Heathkit Tube Checker Kit — Model TC-1			Heathkit A.C. VTVM-KIT — Model AV-1	
	Heathkit Audio Generator Kit — Model AG-7			Heathkit Intermodul. Analyzer Kit—Model IM-1	
	Heathkit Battery Eliminator Kit — Model BE-2			Heathkit Audio Freq. Meter Kit — Model AF-1	
	Heathkit Electronic Switch Kit — Model S-2			Heathkit Square Wave Gen. Kit — Model SQ-1	
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	Heathkit Signal Tracer Kit — Model T-2				
	Heathkit R.F. Probe Kit — No. 309				

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Tiny Personal Set Uses Efficient Circuit

A small, truly portable radio is always handy to have and there are numerous models on the market. But a tiny receiver usable for personal earphone reception is far from common. The Privat-Ear* fills this bill, covering the broadcast band, pulling in stations from as much as 50 miles away, and giving real listening privacy.

The diagram, page 84, shows the circuit used. Two low-current drain 2E31 tubes and a germanium crystal detector provide sensitive reception with adequate volume. A reflex type circuit is used.

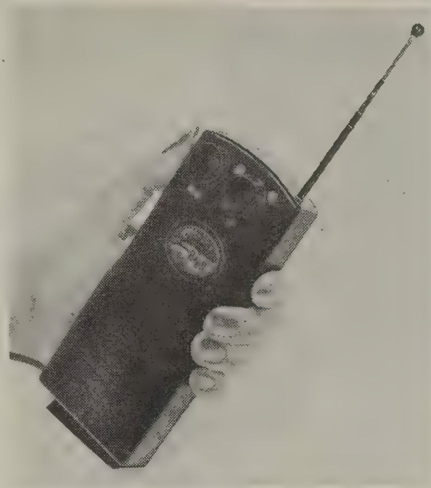
The signal is picked up on the collapsible antenna which extends to 18 inches. A switch on the antenna turns on the set when the antenna is extended. The incoming r.f. signal passes through the first 2E31 tuned by L1 and L2. Then it is rectified by the 1N60 or 1N34 crystal detector and finally passes back through the same 2E31, then on through a standard RC network to the second 2E31 which acts as audio amplifier.

Reflex circuit

The reflex type circuit is one in which the vacuum tubes perform double duties as both radio-frequency and audio-frequency amplifiers. The incoming r.f. signal is amplified at radio frequency (thus giving a stage of r.f.), rectified by a detector, in this case the 1N60 (1N34 can be used), and then amplified at audio frequency using the same tube.

In this particular case no feedback loop is used as in the original reflex, but the amplified r.f. signal is returned to the grid of the first 2E31 by the network, C1, R1, R2.

*Manufactured by Privat-Ear Corp., 2016 Bronxdale Ave., Bronx, N. Y.



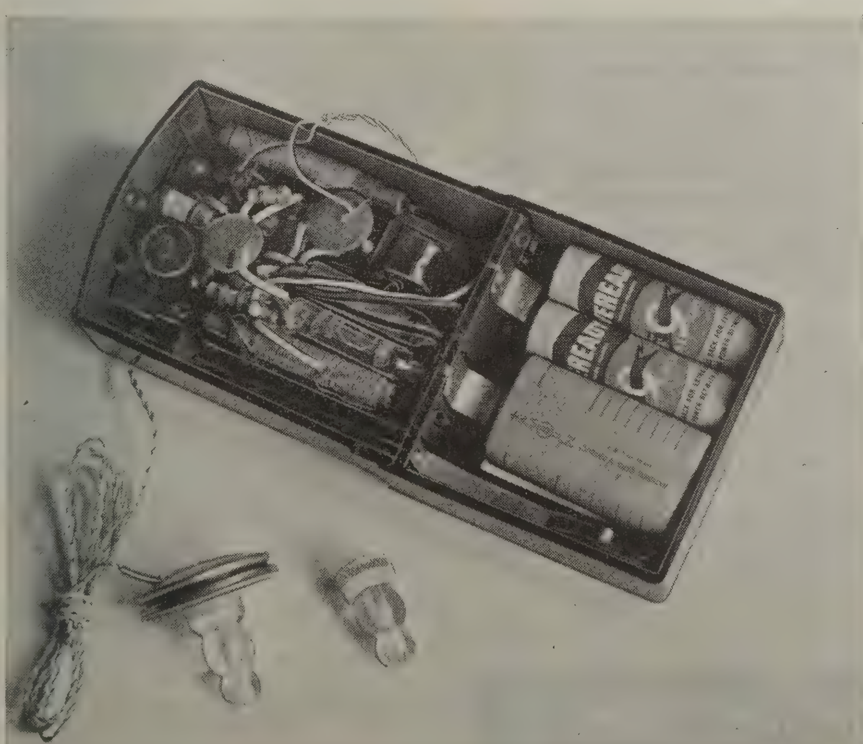
Sensitive receiver covers broadcast band

The circuit may be critical, since both r.f. and rectified audio frequency waves are passed through the same tube. Theoretically the circuit can become unstable if the audio component overloads the tube, but this is unlikely in the present hookup.

Compact construction

The frequency range tuned by the coils is 600 to 1,500 kc. Slug tuning eliminates the need for bulky variable capacitors, and provides fairly high Q for selectivity.

The power output of the small set is about 55 milliwatts, ample for the magnetic headphone used which inserts

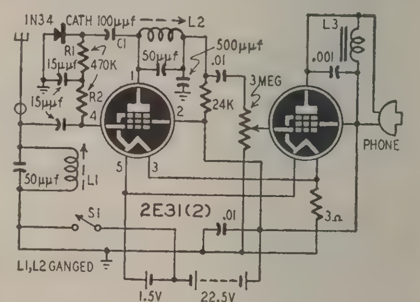


Photos courtesy Alex Taylor and Co., New York, N. Y.

Sensitive unit uses two hearing-aid tubes, 1N60 crystal and miniature parts.

into the ear canal. A choke, L3, provides efficient loading of the audio tube, with proper impedance coupling to the headphone.

Current drain is very low, since the subminiature pentodes draw a total of 100 ma filament current and 0.8 ma plate current. Two 1.5-volt cells and a 22.5-volt hearing-aid battery are used.



S1 ASSOCIATED WITH TELESCOPE TYPE ANT AT POINT ϕ

The simple Privat-Ear reflex circuit.

The compact unit, which weighs less than 8 ounces, requires a minimum of parts. Ceramic-disc capacitors, miniature chokes, and ⅓-watt resistors cut down the size.

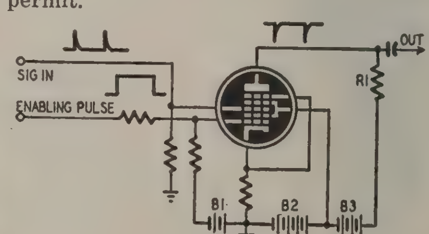
The plastic case measures 2½ x 5¾ x ¾ inches. An extra earplug is furnished, and the unit comes complete with batteries.

—end—

ELECTRONIC GATING CIRCUIT

Gating or keying circuits which permit a tube to conduct and amplify during predetermined intervals and prevent it from amplifying during others are widely used in computers, TV sync generators and timers, radar equipment, and various other devices. Patent No. 2,519,763 issued to R. H. Hoglund describes a simple gating circuit designed around a 6SA7 or similar tube having two grids which are highly effective in controlling the flow of plate current. The basic circuit is shown in the diagram.

The tube is biased to cutoff by the voltage applied to grid 1 from battery B1. Screen-grid voltage is supplied by B2 and plate voltage by B2 and B3 in series. When a signal is applied to grid 3, no output is developed across the plate-load resistor R1 because the tube is cut off by the bias on grid 1. However, if a positive gating or enabling pulse is applied simultaneously to grid 1, the tube will conduct and amplify the signal on grid 3. Because of degeneration produced by the unbypassed cathode resistor, only a small portion of the enabling pulse appears in the output circuit, while the signal applied to grid 3 is amplified as much as the circuit will permit.



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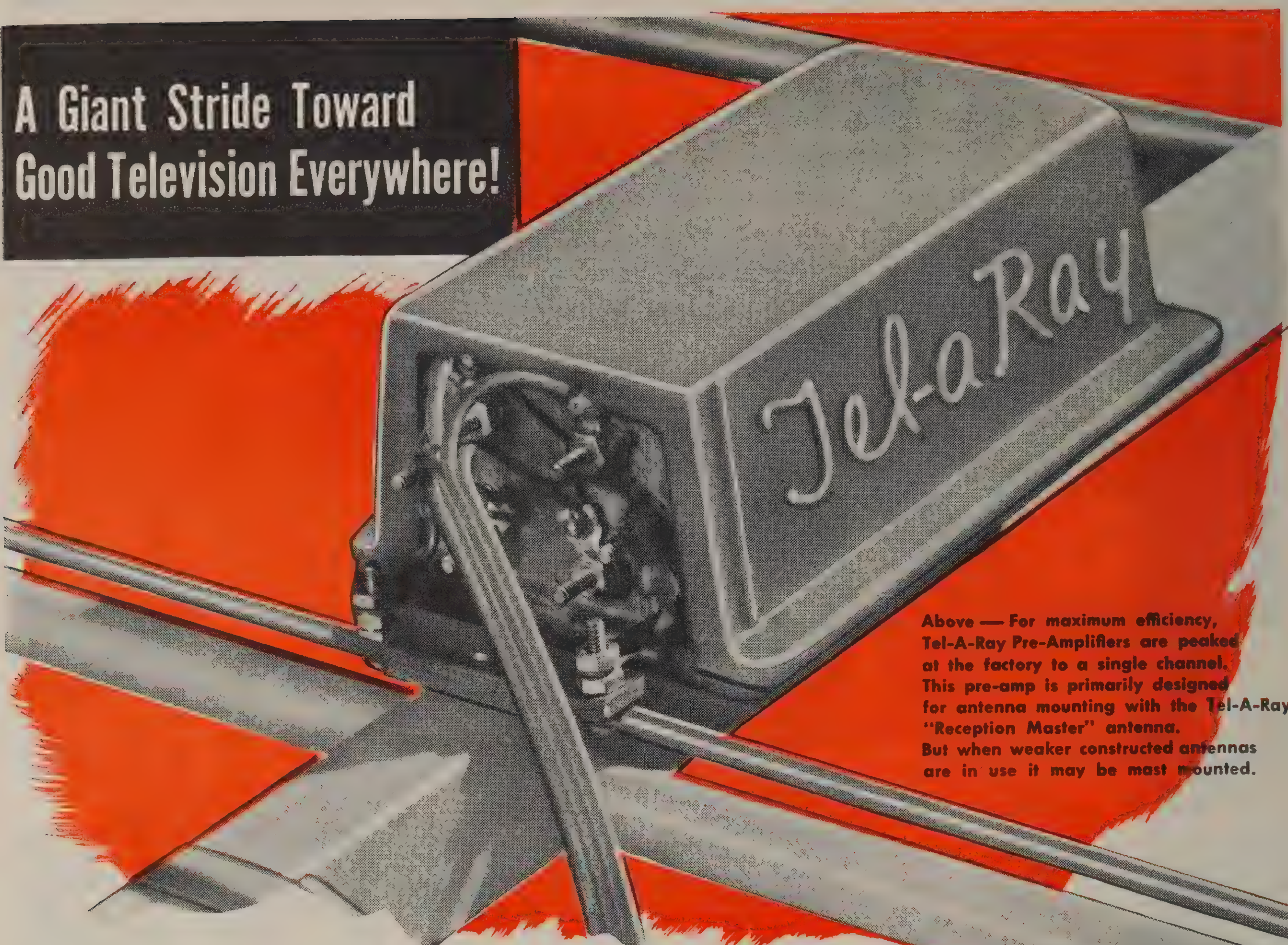
A Giant Stride Toward Good Television Everywhere!



Above — For maximum efficiency, Tel-A-Ray Pre-Amplifiers are peaked at the factory to a single channel. This pre-amp is primarily designed for antenna mounting with the Tel-A-Ray "Reception Master" antenna. But when weaker constructed antennas are in use it may be mast mounted.

New, Improved TEL-A-RAY PRE-AMPLIFIER

gives clean, sharp reception beyond the fringe areas!

Here is an advance that can help sell many more television sets . . . that is a "must" installation wherever signals are weak and snow is a problem.

The only antenna-mounted device of its kind, the new, improved Tel-A-Ray Pre-Amplifier is now made in separate models for high and low channels . . . with a matched and tuned grid circuit that insures maximum gain and a stable signal. With it, television can now go beyond the fringe areas, and you have the simple, easily installed and economical means of insuring clear, sharp, snow-free television reception in many other locations. It is a tremendous advance with all the bugs worked out of it . . . ready for your use now in bringing good television to many more people.

USE WITH MODEL T OR TD ANTENNA for the best results

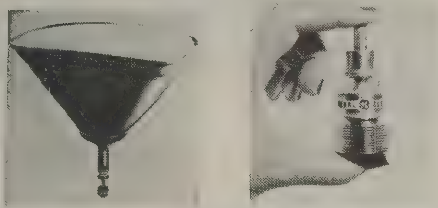
Installation of these famous long distance Tel-A-Ray antennas is the first step in getting clear, snow-free reception. With the Pre-Amplifier, they give up to 300 times gain over dipole.

- Gives maximum gain in signal.
- Insures stability of signal.
- Provides for vastly improved signal-to-noise ratio.
- Compensates for lead line loss.
- Eliminates or greatly reduces snow.
- An essential complement to the booster at the set in many locations, and can be used without a booster in numerous cases.
- Made of Dural and weather-sealed . . . completely guaranteed against weather damage.
- Inexpensive . . . speedily and easily installed to any mast or antenna.

Tel-a-Ray
ENTERPRISES, INCORPORATED
BOX 332E
HENDERSON, KENTUCKY
TRADE MARK

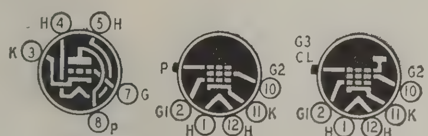
TUBES OF THE MONTH

Among the new tubes this month is the RCA 21AP4, a metal-shell, rectangular picture tube using magnetic focus and deflection. It has a maximum rating of 18,000 volts, a horizontal deflections angle of 66° and requires a single-magnet ion trap. Tube length: 22 3/16 inches picture size: 18⅜ x 13 15/16 inches.



21AP4, metal; GL-2C39A, lighthouse.

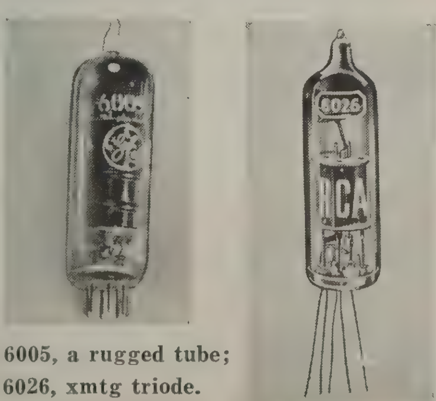
General Electric is producing the GL-2C39A, a high-mu triode, lighthouse tube, designed for use up to 2,500 mc. Maximum d.c. plate voltage is 1,000 volts, and dissipation is 100 watts. It is designed for use as a grounded-grid class-C r.f. amplifier and oscillator, in both fixed and mobile services. Output at 500 mc, operating as a class C oscillator, is 40 watts. At 2,500 mc, output is 15 watts.



6026 12SP7 21AP4

G-E is also producing the 6005, designed mainly for mobile and aircraft applications where shock and vibration are encountered. It is a miniature beam-power amplifier designed for audio-frequency service. It can withstand peak impact acceleration up to 600 g, and vibrational acceleration up to 2.5 g. Maximum ratings of the tube include: plate dissipation, 12 watts; screen dissipation, 2 watts. Power output is 4.5 watts. It is a high-reliability version of the 6AQ5.

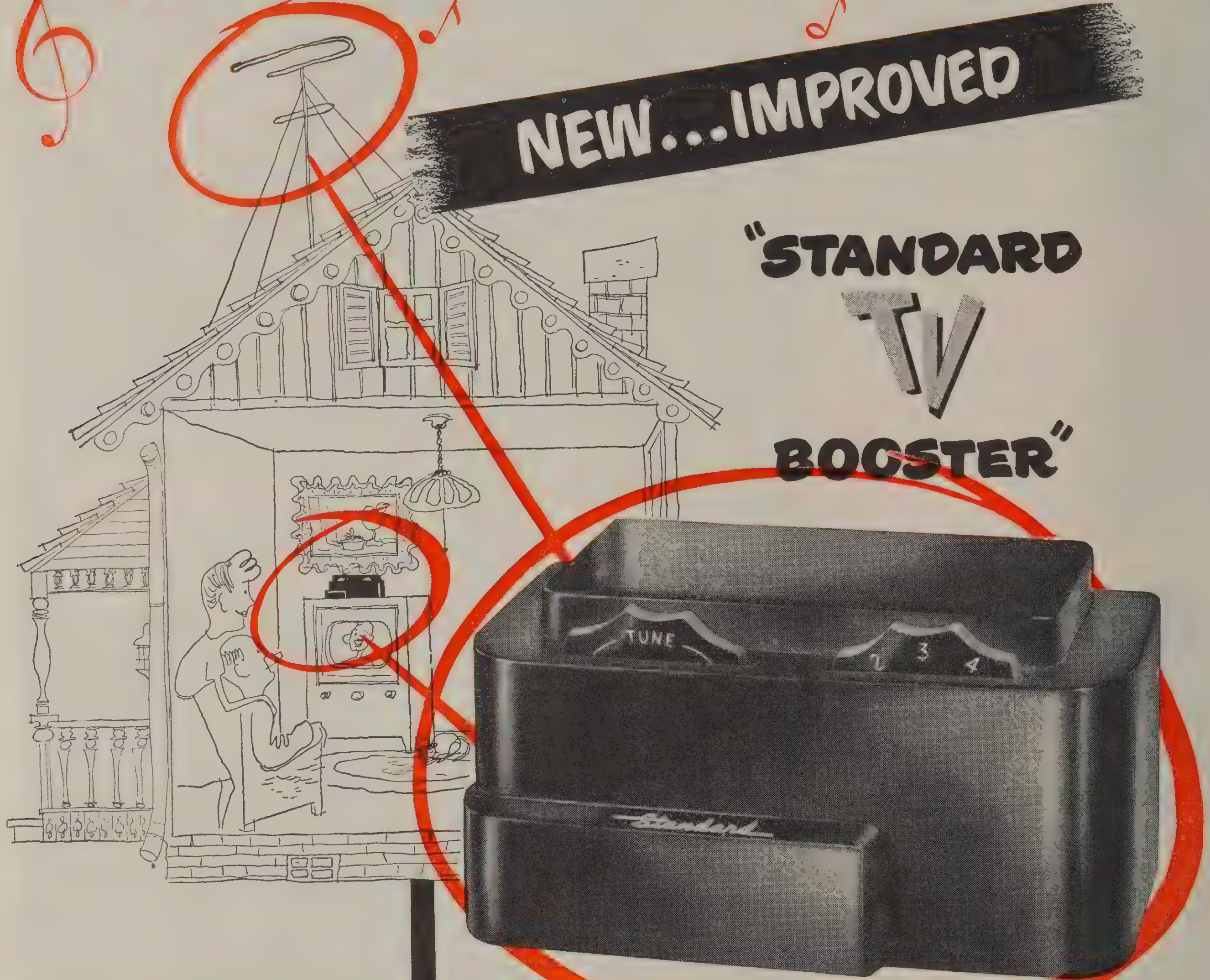
Another RCA tube is the new flexible-lead, subminiature type 6026, a high-efficiency oscillator triode designed for transmitting service at 400 mc in radiosonde and similar applications. The structure of the 6026 permits short transit time and low interelectrode ca-



6005, a rugged tube; 6026, xmtg triode.

IN TUNE WITH THE TUNER!

NEW...IMPROVED "STANDARD TV BOOSTER"

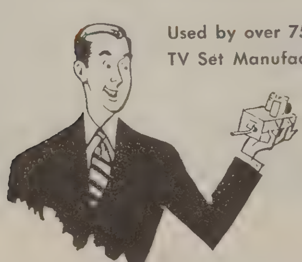


MODEL B-51

Millions of "Standard Tuners"

Now In Use

Used by over 75
TV Set Manufacturers



The new "Standard Booster" will increase the TV signal strength to a degree that will make possible "city" reception in areas remote from the TV transmitter. It reduces the "snow" or noise and interference to give a clearer, sharper picture and improved sound reception. It also makes possible receiving a picture in very remote areas or "blind" areas in close-to-transmitter locations where the TV set alone will not —makes a TV set a real enjoyment!

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pacitance. It has a useful power output of 1.25 watts. Since in most of its applications, tube life is not the primary consideration (usually a life of only a few hours is required), ratings have been established on the basis of power output, compactness, and low weight.

12SP7, radar tube.

A 12-inch cathode-ray tube, type 12SP7, is being produced by RCA for radar indicator service. It is the magnetic focus, magnetic deflection type. The face plate, coated with phosphor P7, has almost a flat surface. The gun design produces a sharper, rounder spot, resulting in greater resolution when the tube is operated at high beam current.

—end—

EMPIRE STATE TOWER

This picture of the Empire State Building multiple TV antenna installation represents a unique solution of a photographic problem. Because it was difficult to get a suitable, complete photo of the inaccessible installation, engineers built a model and photographed that.

The complete installation should be in operation by the time this is read. Transmitted signals cover TV channel 2, 4, 5, 7, and 11, plus three FM stations. Channel 13 will be added later.

CORRECTION

Merit Transformer Corp. has informed us that the MD-70 and MDF-70 deflection yokes are matching units for the HVO-6 horizontal output and high-voltage transformer; not the type MD-12 shown in the tabulation on page 31 of the August issue. The type MDF-70 also can be used with the HVO-7 output transformer.

CENTERING DEVICE

A new picture centering device has been designed for the new type electrostatic focus picture tubes which use no focus coil. It is being marketed by the Perfection Electric Co.

It has two metal rings which can be rotated independently to adjust the picture and center it. The rings are mounted on a special form which is easily clamped to the neck of the tube.

The Kine-Center can be quickly mounted and stays in place without wobble. It can be operated by fingertip control. The two rings are rotated either independently or together to center the picture. When the tabs of both rings are parallel and they are rotated together around the neck of the tube, the picture will rotate in a circle. When the tabs are directly opposite one another and the entire mounting is rotated around the tube, the picture moves very slightly, if at all. When the tabs are placed at any position other than opposite each other, the amount of adjustment of the picture will be between the maximum and minimum, depending upon the position of each tab. Straight-line movement of the picture is obtained by rotating one ring and allowing the other to remain stationary.

—end—

NEW CALLS FOR NOVICE HAMS

On July 1, 1951, novice class licenses became available to radio beginners who wish to become active amateur radio operators while obtaining the experience and know-how necessary to qualify for higher amateur licenses. The beginner must demonstrate his ability to send and receive International Morse code at the rate of five words per minute. He must pass a simple written examination which includes questions on rules and regulations essential to novice licensees and a few questions on elementary radio theory.

Distinctive prefixes are used on call signs issued to stations licensed to holders of novice licenses. In the continental United States where the call-sign prefix is a single W or K (such as W2ABC or K2ABC), the letter N is inserted between the normal prefix and the numeral designating the call area. Thus call signs for novice stations would then be WN2ABC and KN2ABC.

Two-letter prefixes beginning with K (such as KG4ABC and KR6ABC) are assigned to amateur stations in territories and possessions of the United States. Call signs issued to novices in these areas will have the letter W substituted for K.

Transistors as Multivibrators

By I. QUEEN

Recent patents assigned to RCA for counting circuits use transistors instead of tubes. Transistors require no filament power and they are more compact than tubes. Their disadvantages include a limited r.f. response and low power output. Neither of these is objectionable in a counter.

Transistors were discussed in this magazine in September, 1948, page 24 and in June, 1950, page 66. Briefly, they have three elements which roughly correspond to those in a triode tube. The emitter and collector are catwhiskers in contact with a germanium crystal, and the crystal is soldered to a metal case. Normally the emitter is positive and the collector negative with respect to the base.

Fig. 1 uses two transistors in a multivibrator designed by Raymond P. Moore, Jr. (Patent No. 2,531,076). The usual R-C circuits are not practical due to the low impedance between transistor elements. When no input is impressed, the emitter bias (with respect to base) is adjusted slightly positive. The bias voltage is the difference between that of the emitter battery and the voltage drop across the base resistor.

As with a tube multivibrator, this circuit has two stable conditions. When either transistor is blocked, the other conducts heavily. For example, let TR1 be blocked. Then a relatively large negative voltage exists on COL1. A portion of this voltage is fed through a voltage divider to B2. This is equivalent to a large positive bias on EM2. Therefore TR2 conducts heavily and its collector voltage drops sharply from its high negative voltage. A positive pulse is transmitted to B1 through the voltage divider. This maintains TR1 in a cutoff condition.

The trigger signal to the multivibrator is a series of thin positive square waves. These are differentiated, then impressed on B1. Each differentiated square waves gives rise to a sharp positive pulse followed by a negative one.

Assume that initially TR1 is the conducting transistor and TR2 is blocked. The first positive pulse blocks TR1, and, as previously explained, it permits the

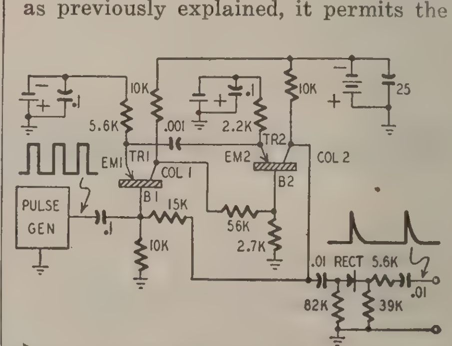

Fig. 1—Multivibrator counter circuit.

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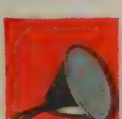

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other transistor to conduct. Additionally, a positive pulse is initiated on EM1 when its current disappears. This pulse is transmitted through the coupling capacitor to EM2 and then it gradually decays. As long as it exists, however, it maintains TR2 conduction and keeps TR1 blocked. This condition lasts until after the arrival of the negative pulse from the differentiating network.

The second trigger signal now arrives. Its differentiated positive pulse can accomplish nothing, since TR1 is already blocked. The negative pulse which follows permits this transistor to conduct and TR2 returns to conduction.

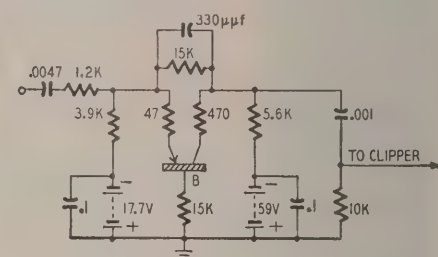

Fig. 2—Transistor in flip-flop circuit.

Output from COL2 passes through a clipper. This first differentiates the voltage, then rectifies it. The result is one positive pulse for each pair of trigger pulses.

The circuit shown in Fig. 2 also has two states of equilibrium, although it needs only one transistor. Of course it does not have the gain of the previous circuit but it can be used where the trigger pulses have relatively large amplitude. This flip-flop circuit was designed by Everett Eberhard (Patent No. 2,533,001).

As before, a differentiating network provides a positive pulse followed by a negative one for each trigger signal. The positive pulse raises the bias on the emitter and permits current flow in the collector circuit. Conduction is aided by positive feedback as follows: More current flows through the base resistor, thus increasing emitter bias. Also, the rapid rise of collector current gives rise to a positive pulse through the coupling capacitor to the emitter. A large positive emitter bias exists until after the arrival of the input negative pulse.

As for the next trigger signal, its positive pulse maintains conduction in the transistor. Then the negative pulse blocks the emitter. As in the case of the multivibrator, this flip-flop provides one output pulse for each pair of trigger signals.

The low resistances (47 and 470 ohms) in the emitter and collector are current-limiting resistors. They may be dispensed with if desired.

An important application for these two circuits is for counting pulses. Each stage has a 2:1 reduction ratio. Several stages may be connected in series as desired. It is not possible to obtain decade counting or a 10:1 reduction ratio directly, since 10 is not an integral power of 2. However, feedback may be added in the circuit for this purpose.

—end—

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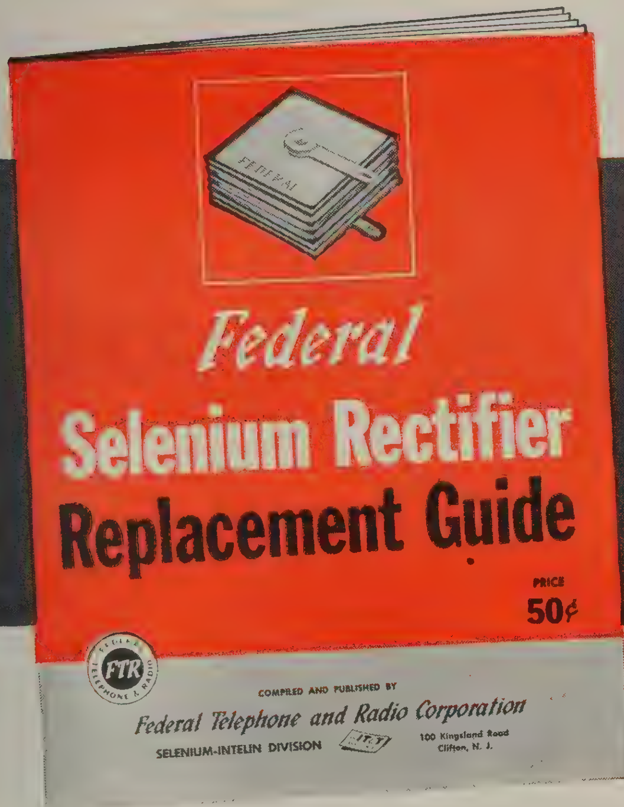

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Dr. C. J. Breitwieser joined P. R. Mallory & Co., Inc., Indianapolis, as executive assistant to Dr. F. R. Hensel, vice-president of engineering. Dr. Breitwieser was formerly chief of electronics and head of the engineering laboratories at Consolidated Vultee Aircraft Corp.

Dr. C. J. Breitwieser

Carl E. Smith, former supervisor of equipment sales service for the radio tube division, Sylvania Electric Products Inc., was appointed supervisor of factory sales service. **Luther C. Henrichs,** former sales account specialist for the division, succeeds Mr. Smith. Sylvania also announced the appointment of W. **Benton Harrison, Jr.** as treasurer of the corporation. Mr. Harrison came to Sylvania from the General Aniline & Film Corp.

C. E. Smith

L. B. Calamaras was promoted to the post of executive vice-president of the National Electronic Distributors Association (NEDA) under a new five-year contract. He had been secretary since 1944. In his new position Mr. Calamaras will represent NEDA in all Government activities. He will also work on the development of a weekly Washington letter for NEDA members.

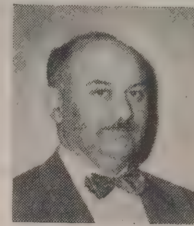
Gordon Groth joined the Erie Resistor Corp., Erie, Pa., as executive vice-president. Mr. Groth was previously president of the Electra Manufacturing Co. In his new position he will be responsible to G. Richard Fryling, president of Erie Resistor, for all phases of the company's activities.

G. Groth

Dr. Robert D. Huntoon was appointed associate director of the National Bureau of Standards in charge of the Bureau's newly-established Corona Laboratories near Corona, Cal. Dr. Huntoon was formerly chief of the NBS Atomic and Radiation Physics Division. The Corona Laboratories will be concerned with various phases of electronic research, development, and engineering.

Louis Kahn was appointed expert consultant on components on the Panel of Components and chairman of the Capacitor Sub-Panel, Research and Development Board for the Armed Forces. Mr. Kahn is director of research for Aerovox Corp., New Bedford, Mass. and a director of Aerovox Canada, Ltd.

Solomon Zimmerman joined the development engineering staff of the JFD MANUFACTURING CO., INC., Brooklyn, N. Y. Mr. Zimmerman, a veteran in the radio-television industry, was previously with the Product Engineering Division of the Teletone Radio Corp.



S. Zimmerman

William C. (Bill) Grunow, founder of the GRIGSBY-GRUNOW CO., original manufacturer of Majestic radio sets, died of a heart attack in Chicago on July 6. He was 58 years old.

Personnel Notes

. . . **Wayne Coy** was approved as chairman of the FCC for a new seven-year term.

. . . **Lieut. Gen. Albert C. Wedemeyer** joined the AVCO MANUFACTURING CORP. as a vice-president and director upon his retirement from the Army on July 31.

. . . **Edmund C. Berkeley**, actuary and engineer, was elected to the Board of Directors of the VIDEO CORP. OF AMERICA, New York City. Mr. Berkeley is the author of the series of articles on the "Electronic Brain" now running in RADIO-ELECTRONICS.

. . . **Ovid Riso** was appointed vice-president in charge of advertising for the PHILCO INTERNATIONAL CORP. He has been with the company since 1944 and is a member of the management committee.

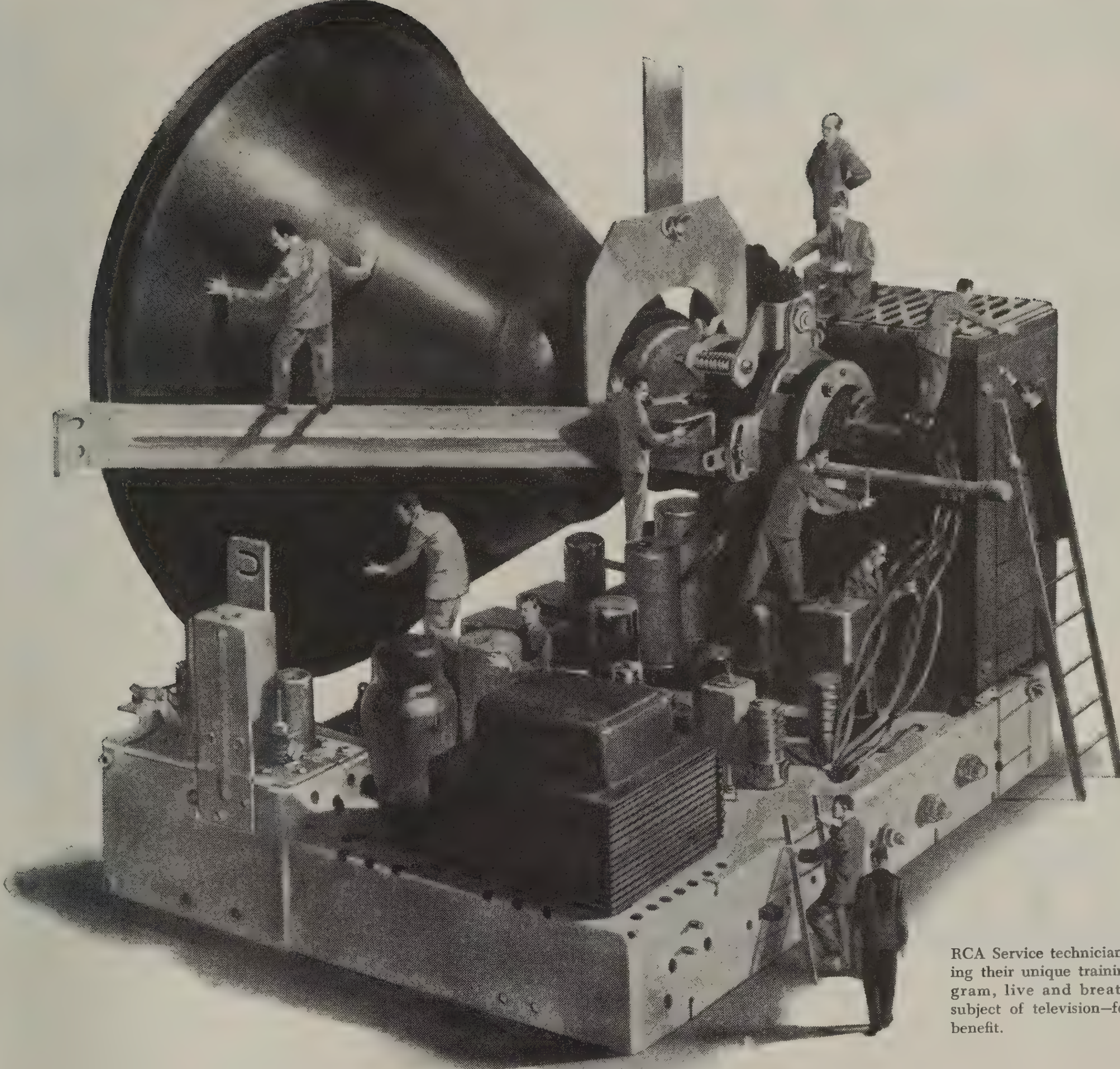
. . . **E. L. Hulse**, former comptroller of GENERAL ELECTRIC CO.'s Electronics Department, was appointed manager of the newly formed Components Division.

. . . **Edmund T. Morris, Jr.**, former assistant to the vice-president and manager of the Electronics and X-Ray Divisions of WESTINGHOUSE ELECTRIC CORP., was appointed director of the Electronics Division of the NATIONAL PRODUCTION AUTHORITY. He continues to serve as chairman of the Electronics Board at the Defense Production Administration.

. . . **Matthew Mandl** and **Edward M. Noll** joined the TV engineering staff of the SNYDER MANUFACTURING CO., Philadelphia, on a full-time basis. Both had been previously associated with the company as consultants. They are recognized as experts in the antenna field and have contributed frequent articles to RADIO-ELECTRONICS.

. . . **Sidney J. Mass**, former director of advertising and sales promotion, was appointed sales manager of the JERROLD ELECTRONICS CORP., Philadelphia. Edmund D. Lucas, Jr., formerly with Philco, joined Jerrold as manager of advertising and public relations.

—end—



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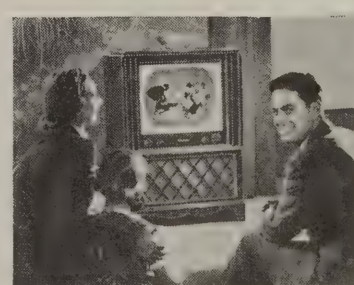

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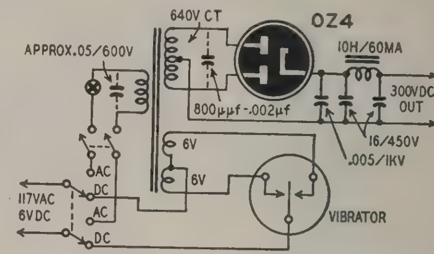
DUAL POWER SUPPLY

Power supplies delivering approximately 300 volts are handy for checking and aligning radios while awaiting the arrival of a new power transformer or vibrator. The supply shown in the diagram is designed to operate from 117 volts a.c. in the shop or a 6-volt d.c. source when servicing battery-powered amplifiers and radios away from power lines.

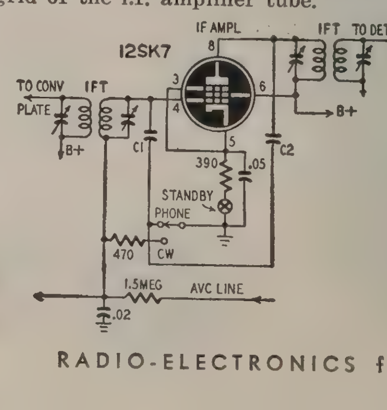


The unit uses a power transformer with two 6-volt filament windings. These are connected in series-aiding and are used as the low-voltage primary. The ends of the series-connected windings are connected to the contacts on the vibrator. A buffer capacitor should be added to minimize sparking at the vibrator contacts. The buffer may be connected across the 117-volt primary or the high-voltage secondary windings. Typical values are shown on the diagram. Connect a d.c. ammeter in series with one lead from the battery and use the capacitor which gives the lowest line current. Always remove the vibrator when using the supply on a.c.—*A. Ivanivsky*

NOVEL B.F.O. CIRCUIT

There are a number of multi-band broadcast receivers which cover one or more of the amateur bands. Many can be modified for c.w. reception with the simple b.f.o. circuit used in the Hallicrafter S-38B receivers.

A single 470-ohm resistor and a s.p.d.t. switch is added to the circuit of the i.f. amplifier as shown in the diagram. When the switch is in the cw position, the i.f. amplifier oscillates because of feedback from plate to grid through C1 and C2 in series. The a.v.c. line is grounded through the 470-ohm resistor to prevent the oscillations from increasing the a.v.c. voltage and reducing the gain of the receiver. In the PHONE position, C1 and C2 are grounded at their junction and the set operates normally. C1 and C2 may be ceramic capacitors of 1 μμf or so or they may be two or three turns of insulated wire wrapped around the leads to plate and grid of the i.f. amplifier tube.



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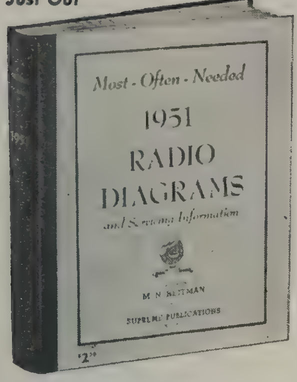

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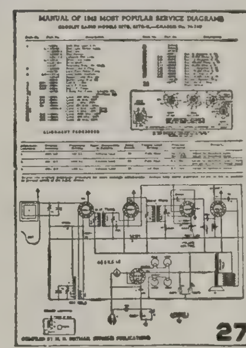

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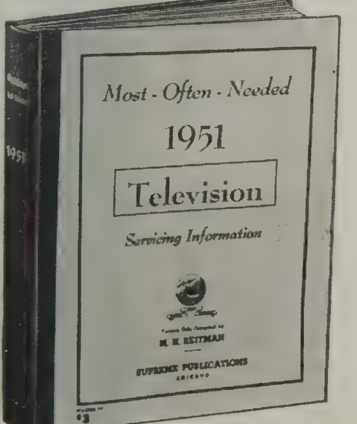

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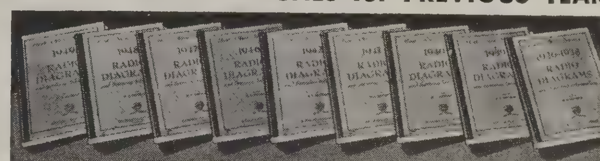

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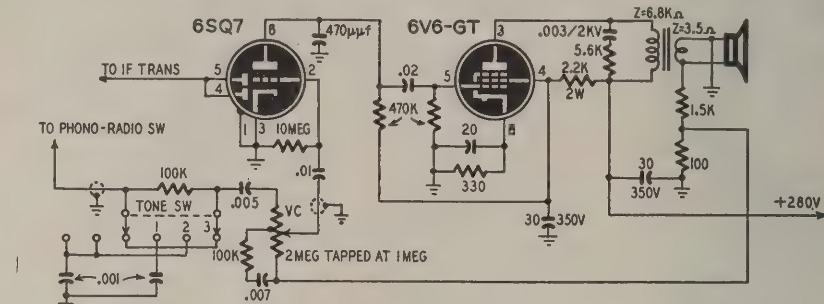
A novel audio amplifier which incorporates inverse feedback and a low-pass filter type tone control is used in the G-E model 303 table radio-phonograph. The phonograph uses a variable-reluctance pickup working into a standard preamplifier (not shown in the diagram). Approximately ½ watt of power is developed across the voice coil when .05 volt at 400 cycles is fed into the high side of the volume control. Maximum undistorted output is 3 watts.

The feedback voltage is developed across the 100-ohm resistor connected between the low-volume side of the volume control and ground. The 100,000-ohm resistor and .007-µf capacitor are connected in series across one-half of the volume control to provide bass boost at low volume levels. Surface noise, scratch, and some highs are attenuated by setting the tone control to positions 1 or 2. The tone control is out of the circuit when the switch is in position 3.

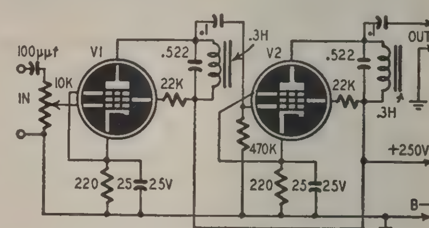


PRECISION AUDIO TONES FROM POWER LINES

Single-frequency tones having good waveform, stability, and accuracy are often needed to excite bridges and for other purposes in an electronic laboratory or service shop. A novel 400-cycle source which is basically a tuned amplifier fed at power-line frequencies is described in *Electronic Engineering* (London, England). The circuit is shown in the diagram.

The input of the two-stage tuned amplifier is coupled to one of the rectifier plates through a differentiator consisting of the 100-µµf blocking capacitor and the grid resistor for the input stage. The purity of the output waveform is governed by the Q of the tuned circuits, which must be adjusted to resonate precisely at the desired frequency. In one model the tuned circuits had a Q of 20, and all hum and distortion component peak values did not exceed 1%.

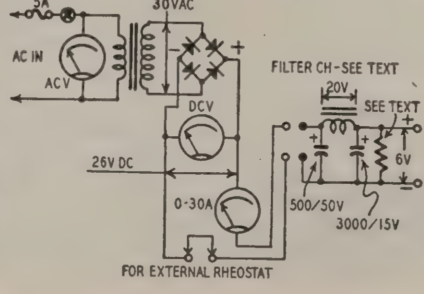
The power lines in Britain operate at 50 cycles so the 400-cycle note was obtained by amplifying the 8th harmonic. Tones of 360, 420, 480 cycles or any reasonable multiple of 60 can be obtained by using 60-cycle a.c. lines as the standard. In this case, the values of the inductors and/or capacitors must be changed accordingly. A reactance slide rule is useful in determining the proper values.



V1 and V2 may be any convenient high-gain pentodes. Values shown are suitable for EF50's. Other tubes such as 6AC7's, 6AK5's, etc., will work equally well and can be substituted, but the values of the screen-grid and cathode-biasing resistors must be changed. Bypassing the screens may provide slightly more gain, but the waveform should be checked before and after to determine the effects of the bypass capacitor.

SIMPLE D.C. SUPPLY FOR 6- OR 26-VOLT SERVICE

Every radio service technican can make use of a low-voltage d.c. supply for testing automobile and battery-powered radios d.c. relays, small motors, etc. We have constructed a supply of this type which delivers 26 volts d.c. unfiltered and 6 volts d.c. out of a capacitor-input filter. The circuit is shown. The rectifier and meters are on one chassis and the filter on the other.



The transformer was wound to deliver 30 volts a.c. We selected an old power transformer which had a core area of approximately 3 square inches. After rewinding the primary with 250 turns of No. 20 enameled wire, we wound on 60 turns of No. 12 wire for the secondary. The choke was made by winding 800 turns of No. 26 wire on the 1-inch square core from an old filter choke.

The resistance of the choke is used to drop the output to 6 volts under load. A low-resistance, high-wattage

variable resistor is used across the output of the filter to adjust the output voltage to the required value under light loads and to prevent the voltage from soaring when the load is removed.

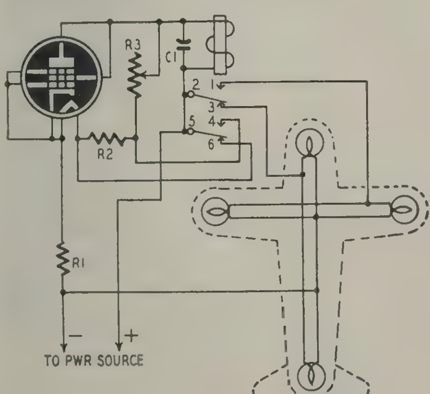
Some surplus filament transformers deliver 24 volts at several amperes. One of these will supply 18 to 20 volts from the average dry rectifier. Greater output can be obtained by connecting the secondary of a heavy 6-volt filament transformer in series-aiding with the 24-volt winding and connecting the two primaries in parallel. You can use a filter choke of 30 to 50 mh at the desired current rating. These are available from sources manufacturing components for low-voltage, high-current supplies.—*A. Ivanivsky*

AIRCRAFT LIGHT CONTROL

A simple electronic timer suitable for controlling aircraft running-lights and similar devices is described in patent No. 2,534,299 issued to Alfonso J. Ruiz and Eugene J. Kupjack. The unit is particularly applicable to aircraft because it is sturdy, light in weight, and consumes comparatively little power. It produces predetermined on-off cycles which are substantially independent of temperature and pressure.

The operation of this circuit is based on heating and cooling of the heater of an ordinary diode or a multi-element tube connected as a diode as in the diagram. The unit operates from a.c. or d.c. sources. When d.c. is used, its polarity must be as shown.

When the relay is unenergized, heater voltage is applied through the normally closed contacts 5 and 6. R1 drops the supply voltage to the proper value for the heater. When the tube reaches operating temperature, its plate draws current and the relay pulls in. Capacitor C1 is charged by the voltage drop across the relay coil. When the relay is energized, R2 is automatically inserted in series with one side of the heater circuit. The value of this resistor is such that the heater current is limited to a point below that needed to maintain the cathode at proper operating temperature.



As the cathode cools, the plate current drops and C1 discharges gradually through the relay coil, keeping it energized until the plate current is much less than the hold-in current of the relay. The time that the relay remains pulled in is determined by the

resistance of the relay coil R3 and the capacitance of C1. When the relay drops out, full heater voltage is again applied to the tube and the cycle repeats. A second set of s.p.d.t. contacts control external circuits such as aircraft running-lights as shown in the diagram.

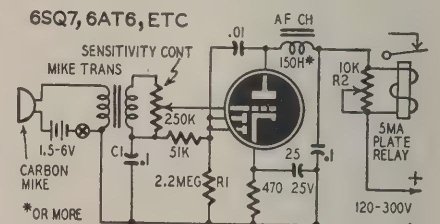
Battery type tubes can be used for on-off cycles as short as one-eighth of a second. Tubes having 117-volt heaters can be used for time cycles of approximately 5 seconds or more.

A blinker circuit of this type has a number of interesting possibilities in the field of industrial electronics, particularly when used in conjunction with other control circuits. Model railroad fans can use such a system to operate crossing, block, and caution signals on their favorite track layouts.

Because of the snap-action of the relay, this system will probably cause less arcing and subsequent interference than the more conventional thermal or motor-driven blinkers used in Christmas-tree lights, signs, and other devices used for display purposes.

SOUND SWITCH

Sound-operated relays or switches have many useful applications such as: turning on a light; sounding an alarm when a baby cries; or as an automatic talk-listen switch for intercoms and radiotelephone transmitters. Most circuits of this type have three of more separate tubes which operate as sound amplifier, rectifier, and relay-control. A circuit which requires only one tube for these functions is described in *Radio Constructor* (London, England).



The circuit shown uses a double diode-triode such as a 6SQ7 or 6AT6 along with a high-output carbon microphone and a high-gain transformer. The amplified output of the microphone appears across the a.f. choke which is the plate load for the triode. The amplified audio voltage is fed to the diode plates to develop a negative voltage across the diode load resistor R1. This voltage charges C1 and biases the triode grid to the point where the plate current drops enough to release the relay. When the sound stops, the charge leaks off C1, plate current increases, and the relay returns to normal (pulls in). The speed with which the relay returns to normal depends on the values of C1 and R1. Increasing the size of either or both increases the time-delay action.

The sensitivity control is adjusted so ordinary background noise will not operate the relay. R2 is set to the point where the relay just pulls in with no input to the microphone.

—end—

COLOR TELEVISION TRANSMITTER CONTROL

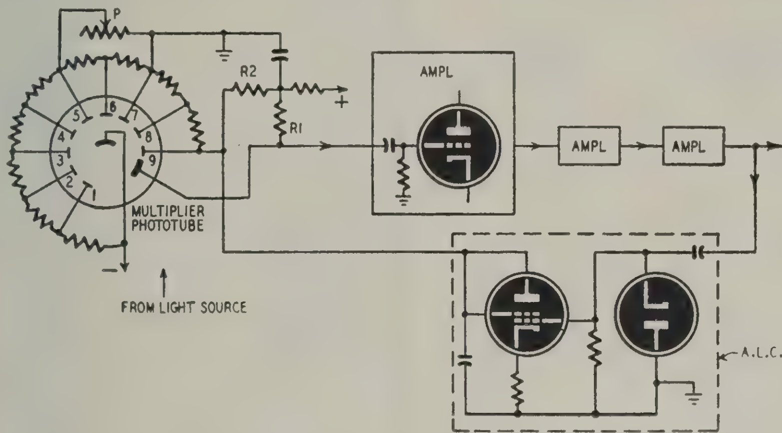
Patent No. 2,548,829
George C. Sziklai, Princeton, and
Milton Rosenberg, Trenton, N. J.
(Assigned to Radio Corp. of America)

This system applies especially to TV transmitters which use color films or slides. As the film is scanned by the cathode-ray "flying-spot" tube, the light beam is focused on a phototube. The tube gain is governed by an automatic level control (a.l.c.) to prevent overloading on film highlights. The automatic level control is shown within dotted lines.

Light from the scanned film falls on the cathode of the phototube. Secondary emission from the dynodes successively multiplies the output. The collector current flows through R1 and a *negative* voltage is applied to the 1st video-amplifier stage. Since each stage reverses the polarity, a *positive* signal is fed to the a.l.c. This signal increases with the intensity of light to the phototube.

In the a.l.c. circuit the voltage is rectified and a positive voltage appears at the tube grid. The increased plate current flows through R2 which drops the dynode voltages. Therefore the gain of the phototube drops while film highlights are being scanned.

A manual gain control is also included at P. As P is decreased it shunts out dynodes 5, 6, and 7 and lowers the total gain of the phototube.



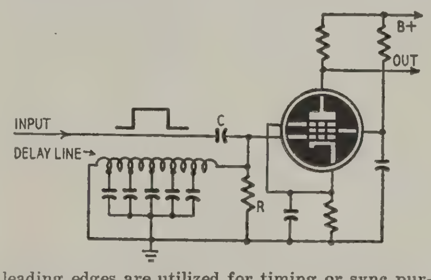
PULSE AMPLIFIER WITH DELAY LINE

Patent No. 2,543,431
Leon Bess, Kansas City, Mo.
(Assigned to United States of America
as represented by the Secretary of War)

This pulse amplifier has a low recovery time or interval during which it is blocked. It also eliminates low-frequency interference such as microphonics. The circuit is especially suitable for timing or sync purposes where the leading pulse edges are utilized.

An R-C network couples the pulse source to the tube. To attentuate the undesired low frequency, the R-C time-constant should be *small*, but this causes the pulse signal wave shape to be distorted. There is a large recovery time during which the tube is blocked. On the other hand, a relatively *large* time-constant would transmit the low-frequency interference.

A delay line solves the problem. This is a circuit made up of series inductance and shunt capacitance. This line shorts out the low frequency, but offers impedance to the high-frequency components of the signal. Due to charging and discharging of the shunt capacitances, the pulse is delayed. Arriving at the line termination (which is shorted), the pulses are reflected because of impedance mismatch. They arrive back at the grid with reversed polarity and delayed in time. The pulses are much narrower than the original, but this is no disadvantage if only the



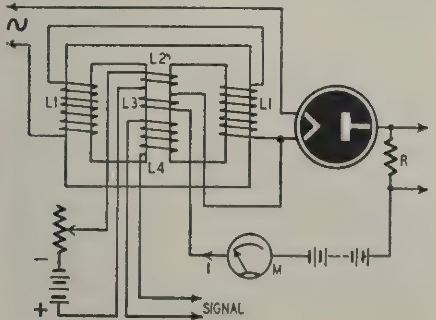
leading edges are utilized for timing or sync purposes. The grid recovers after a short interval and is ready to receive other signals or pulses which follow.

HIGH GAIN MAGNETIC AMPLIFIER

Patent No. 2,548,049
Robert W. Olson, Dallas, Tex.
(Assigned to Geophysical Service, Inc.)

This amplifier has sufficient gain to operate from a thermocouple. It combines the effects of magnetic saturation and thermionic emission.

The a.c. for the diode filament is limited only by the reactance of coils L1. Plate current flows through the load R, meter M, and returns through L3. The coils L2, L3 are wound to magnetize the core in opposite directions.



Initially, L2 partly saturates the core. After the a.c. is turned on, current I tends to reach some definite value and remains constant. If it were to *increase*, for example, it would desaturate the core and increase the reactance of L2. On the other hand, a *decrease* would further saturate the core and reduce the reactance of L2. In either case there is opposition to a change in I once it has reached stability.

The stable value of I depends upon core saturation. This is set initially by the battery current through L2. When a signal flows through L4, it controls the saturation and therefore determines the value of I (as measured by M). If L4 is wound with many more turns than L3, the output (I) is greatly amplified. For maximum gain, the diode should be operated on the steepest portion of its Ef-Ip characteristic.

L.F. MAGNETRON AMPLIFIER

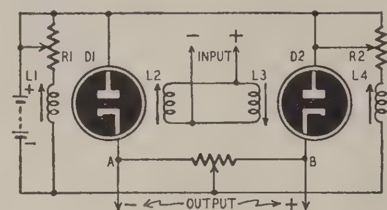
Patent No. 2,546,033

Chester R. Knight, Scotia, N. Y.

(Assigned to General Electric Co.)

This high-gain amplifier uses 2 magnetrons per stage. It eliminates contact potential errors and has high stability. It is effective at low frequencies down to d.c.

A magnetron is a diode with a straight wire cathode surrounded by a cylindrical anode. It requires an external magnetic field parallel to the cathode. Electrons from the cathode are attracted to the positive anode. The electrons tend to move simultaneously in circular orbits around



the cathode. But due to the magnetic field, under the combined effects of the anode and the field, electrons travel along spiral paths which begin at the cathode and terminate at the anode.

If the field is intensified, some electrons assume circular paths about the cathode and do not reach the anode at all. Further increase in flux density reduces the space current because still more electrons do not reach the anode. A typical magnetron characteristic is almost flat up to a critical flux density, then current drops sharply toward cut off.

Each magnetron is surrounded by a pair of coils to generate the required field. Coils L1, L2 energize magnetron D1. The arrows indicate that their fields are additive. Coils for D2 have opposing fields.

With zero signal input, R1, R2 are adjusted to bias the magnetrons to a critical operating point. Therefore the space currents are sensitive to either decrease or increase of flux density. The output voltage is initially balanced to zero by R3.

When d.c. (or slowly varying a.c.) is fed to the amplifier, the field of one magnetron is strengthened and the other weakened. For example, if the signal has polarity as indicated, the field acting on D1 is strengthened so this tube passes less current. D2 conducts more freely at this time. The currents through R3 are no longer equal (and opposite) so output appears between terminals AB.

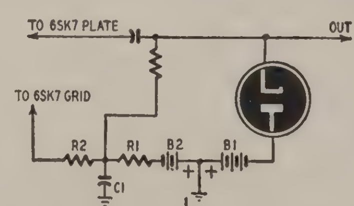
AUTOMATIC GAIN CONTROL

Patent No. 2,552,586

Thomas A. Read and Herbert I. Fusfeld, Philadelphia, Pa.

(May be manufactured or used by the U. S. Government without royalty payments)

This control is more sensitive than previous ones. Unlike conventional circuits, this arrangement *reduces* control bias to decrease gain. Gain may be controlled either by increasing the bias or decreasing it. Higher sensitivity is obtained by the latter method. Signals from the amplifier



(6SK7, for example) are fed to a rectifier which is normally blocked by B1. When the signals are large enough, they overcome the bias and permit tube conduction. A positive drop is produced across R1. This opposes the effect of the bias battery B2, and the 6SK7 grid voltage is reduced toward zero. Therefore the amplifier shows less gain.

The 6SK7 screen voltage should be maintained constant by a VR tube rather than through a dropping resistor. This prevents overloading the screen at low control bias. The plate voltage should be low.

A.C. POWER MEASUREMENT

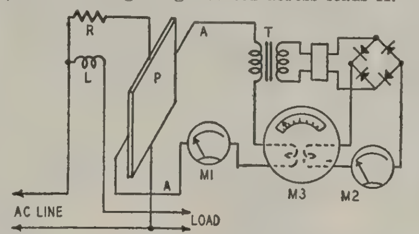
Patent No. 2,550,492

Norval P. Millar, Danvers, Mass.

(Assigned to General Electric Company)

This is a new application of the Hall effect. When connected across an a.c. line, the device indicates load power as well as power factor.

P is a Hall plate, for example a piece of germanium ¼-inch square and .015-inch thick. L generates a magnetic field proportional to *current I* through the load. Current through R is proportional to *voltage V* across the load. Under the combined effects of field and current through P, a Hall voltage is generated across leads A.



The voltage has an a.c. and a d.c. component. The first has an average value proportional to VI. The d.c. is proportional to VI cos *O* where *O* is the phase angle.

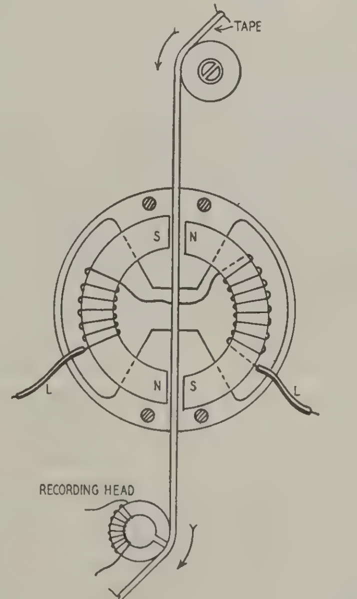
M1 measures the d.c. component. It is calibrated to read VI cos *O* or power. The a.c. component appears across the secondary of T. After rectification it is measured by M2 which is calibrated to read VI or volt-amperes. M3 is a ratio-type meter which indicates the ratio between d.c. and a.c. components. The ratio is the power factor.

MAGNETIC ERASING HEAD

Patent No. 2,550,753

Dallas R. Andrews, Collingswood, N. J.
(Assigned to Radio Corp. of America)

This is a highly efficient erasing head for magnetic tape or wire. It uses 2 separate magnetic gaps, each providing a concentrated high-frequency field, usually 100 kc. Due to the high magnetic intensity, each gap may be wider than in conventional types. This eliminates the possibility of the tape contacting the pole pieces with consequent wow. Ordinarily tape passes over the copper filled gap of a conventional single-ended erasing head, and the magnetic flux arches due to the eddy current effect. Here, a solid cloud of flux is formed, hitting the whole tape.

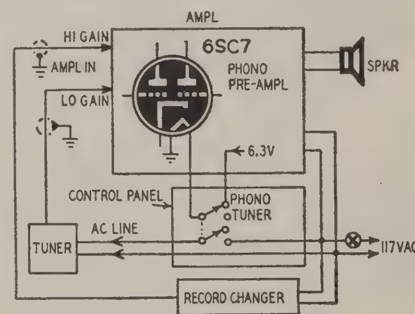


The high frequency is fed to erasing coil leads L as the tape is moved downward between poles SN. The poles are not directly opposite each other but are *diagnally* offset. Therefore flux flows at an angle through the tape. More tape is demagnetized at the same time than if the poles were directly opposite each other. The tape is acted upon successively by the 2 pairs of poles. After erasure, the tape is ready for recording.

—end—

PHONO-RADIO SWITCHING

In a custom radio-phono installation, the problem was to connect a Meissner FM tuner and a record player to a high-gain amplifier which had a low-gain input for a tuner and a built-in pre-amplifier for the variable-reluctance pickup cartridge. A method of switching the inputs had to be devised because no provisions were made for this on the amplifier. The tuner has a change-over switch but manufacturer's instructions state that the switching circuit should not be used with low-level magnetic pickup. Hum would be too great with a 10-microvolt input signal.



Standard input-switching circuits were tried but none could be made to work satisfactorily without major changes in the amplifier circuit. Hum pickup and feed-through were the major objections. Furthermore, any noise, hum, or microphonics developed in the phono preamplifier could be heard when the tuner was in use. Cushioning the preamp against shock did not help.

The problem was solved by connecting the units as shown in the diagram. The record changer and tuner are connected to the input of the amplifier at all times. One side of the preamplifier heater lead was broken and connected to one side of a d.p.d.t. switch on a control panel. The other side of the switch was connected in series with one of the a.c. leads to the tuner. This switch is wired so the preamplifier heater circuit is open when a.c. is applied to the tuner. Thus there is no possibility of preamplifier hum or microphonics when the volume is turned up on FM. An added advantage of this switching system is that the preamplifier tube will probably last longer because with this circuit it is turned off when not in use.—*Nicholas B. Cook*

RADIATION DETECTOR USES

I've had lots of fun experimenting with the radiation detector described in the article "Everything Radiates" in the March, 1950, issue of RADIO ELECTRONICS. It is quite useful in checking transformers and chokes for shorted turns. I find that a ragged hum or chatter will be heard in the phones when the probe is held close to a partially shorted choke or transformer. The circuit under test must be operating to get an indication.

Incidentally, an NE-57 neon lamp is more sensitive than the NE-51 specified in the article.—*O. C. Vidden*

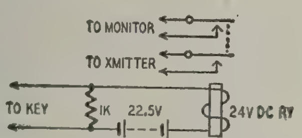
RENOVATING SHORTED 12JP4'S

High-resistance shorts between grid and cathode are common troubles in 12JP4 TV picture tubes. They cause loss of sync pulses which thus produces tearing in the picture. In most cases the short can be burned out by applying a high voltage between the shorted elements.

Like most experimenters and service technicians, we did not have a source of voltage which would do the job. We hit on the idea of using an automobile ignition system to supply the voltage. We grounded one of the elements to the frame of the car and held the lead from the other near a spark plug while the motor was running. This method worked three out of four times and enabled us to continue to use tubes which ordinarily would have been discarded.—*Leonard Pfeiffer*

KEY-CLICK ELIMINATION

I use a surplus 24-volt d.c. relay and a 22.5-volt battery for keying my c.w. transmitter. When the keying relay was first connected, a spark jumped across the contacts each time the key was opened. This spark caused some TVI, pitted the key contacts, and caused an annoying click in the monitor.



These troubles were eliminated by connecting a resistor across the contacts of the key. The exact value of the resistor must be determined by experimenting because the optimum resistance is determined by the battery voltage and the characteristics of the relay. Use the lowest value which can be connected across the open key without closing the relay. The diagram shows the circuit of the keying relay and the resistor.—*Dominic Angelo*

HUM REDUCTION METHOD

Many small receivers have high hum levels which are annoying under some conditions yet cannot be traced directly to any particular circuit defect. Most of these sets have .01-μf or larger coupling capacitors between the plate of the first a.f. amplifier and the grid of a beam-power output tube. When working into the usual 470,000-ohm grid resistor, the capacitor provides bass response considerably lower than the speakers can handle.

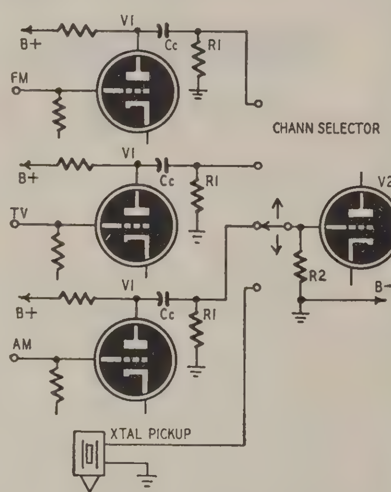
Change the coupling capacitor to 500 μμf. This provides sufficient attenuation for 60- and 120 cycle hum originating in or before the first a.f. amplifier but it does not eliminate the harmonics. Fortunately, these frequencies are at lower levels than the fundamental and are masked by the signal frequencies.

Hum originating in the power amplifier can be eliminated by additional filtering and adequate shielding in the grid circuit.—*Charles Erwin Cohn.*

THUMPLESS A.F. SWITCHING

It is becoming increasingly popular to use a single a.f. system for phonographs, recorders, and AM, TV, and FM radios. A selector switch connects the amplifier input to the output of the various devices. The most commonly used switching circuit is shown in the diagram. This circuit has the disadvantage of producing an annoying plop or thump in the speaker each time the selector is turned to a position other than PHONO.

When the selector is turned to any position, the coupling capacitors Cc of the other positions are not charged because one plate is floating. When the selector is thrown to any position having a coupling capacitor, the capacitor



charges to the d.c. potential on the plate of V1 and applies a strong transient pulse to the grid of V2. Since V2 seldom requires more than a volt or two to drive the amplifier to full output, the pulse produces a loud thump in the speaker.

I eliminate this annoyance by connecting a resistor (R1) on the output side of each coupling capacitor. These resistors keep the capacitors charged so the plates on the output side are always at ground potential. Since the grid of V2 is also at ground potential, the various circuits can be switched in and out without thumping. The value of R1 should be fairly high—5 megohms or so—or 8 to 10 times R2, to prevent its affecting the loading and frequency response of the circuit. R1 is not necessary in input circuits for crystal pickups which are at zero d.c. potential. —*Norman C. Fulmer*

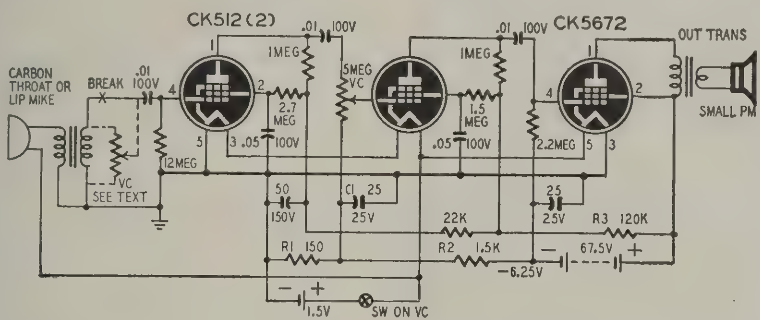
(The amount of thump (sharpness of transient) depends on the size of the coupling capacitor and R1. The time it takes for a capacitor to charge to 63% of applied e.m.f. is the time constant. T = CR; the time combination, .01 x R1, is shorter than .25 x R1.

You may also try using larger coupling capacitors. This reduces charging thump pulse, increases charging time, and also gives better low frequency response.—*Editor*)

—end—

SPEAKING AID PORTABLE AMPLIFIER

? *A friend suffered a throat injury which left him unable to speak above a whisper. He would like to have a small amplifier which will amplify his feeble voice and radiate it from a small speaker which can be carried on his person. The unit must be battery-operated and should use miniature or subminiature tubes. It should be small enough to be built into a case about the size of a hearing-aid.—D. M. H., Renforth, N. B.*



A. A diagram of a small amplifier using subminiature tubes is shown. The CK5672 will deliver approximately 65 milliwatts of power. For higher gain and greater power output—approximately 270 milliwatts—use a 1S5 or 1U5 as speech amplifiers and a 1S4 or 3S4 with parallel-connected filaments as the power amplifier. Use a 90-volt B-battery, remove C1 and ground the lower end of the volume control. Remove R2 and R3 and change R1 to 560 ohms. The output transformer for the 1S4 or 3S4 should have an 8,000-ohm primary and is a standard unit.

If the input stage overloads and causes distortion at high volume levels, replace the present volume control with a 10-megohm resistor. Connect the 5-megohm control directly across the secondary of the microphone transformer, connect its arm to the input side of the blocking capacitor and break the lead from the top side of the transformer secondary.

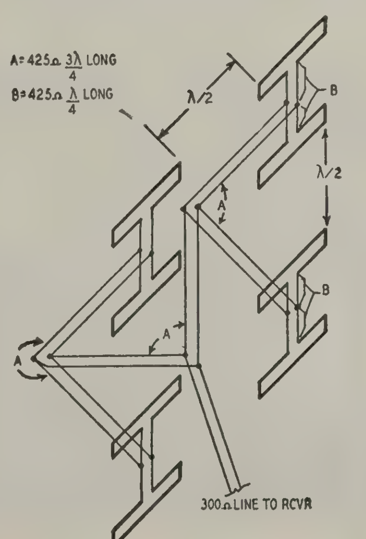
We suggest that you try carbon-type lip and throat microphones to determine which works best. These cut down external noise pickup.

STACKING AND PHASING 8-ELEMENT YAGIS

? *In the Question Box of the July, 1951 issue you showed how to stack four 300-ohm Yagi antennas. Will it be worthwhile for me to stack eight Yagi antennas for more gain. If so, please show the necessary phasing arrangement.—K. W., Sheboygan, Wis.*

A. Stacking Yagi antennas eight elements high will produce a vertical response pattern so sharp that orientation for maximum gain will be extremely difficult. We suggest using the Yagis you have to make an array four elements high and two elements wide and thoroughly brace it.

The connections for the phasing and matching sections for 300-ohm antennas are shown in the drawing. Only the driven elements are shown for simplicity.



The 425-ohm lines can be constructed from ¼-inch tubing spaced 4½ inches or No. 12 wire spaced 1½ inches. The same phasing arrangement can be used for stacking the antennas eight elements high or wide. We do not recommend using Yagis with more than four elements. A greater number of elements with the usual 0.1-wavelength spacing may result in such narrow band width that the antenna will not properly cover the channel for which it is cut.

USING 400-CYCLE SELSYNS ON 60-CYCLE LINES

? *I have a pair of 110-volt, 400-cycle selsyns that I would like to use on 117-volt, 60-cycle lines. Is there any way in which I can do this without damaging the units?—E. A. V., Nazareth, Pa.*

A. Selsyns, motors, and relays designed for 400-cycle service can often be operated successfully on 60 cycles by reducing the input voltage to one-half or one-third of the rated voltage. Use a step-down transformer, dropping resistor, or series capacitor to drop the voltage to 55 volts, 35 volts, or even lower. Use the lowest voltage that gives the required torque without heating.

PARTS LISTS

Bills of material for most of the pieces of equipment described in RADIO-ELECTRONICS construction articles are on hand at all radio dealers and distributors who sell the magazine. See your dealer for a complete parts list of any of this apparatus you wish to construct.

CENTERING TV PICTURE

? *My TV set is a Philco 50-T1403. The volume was low so I checked the tubes and found that the 7F8 was bad. The volume came up to normal but the picture shifted over to the left and there is a crescent-shaped dark area around the left side and bottom of the picture. Can you tell me what causes this condition and describe a means of curing it?—J. S. T., Somerset Center, Wash.*

A. Most likely you accidentally shifted the positions of the deflection yoke and focus coil while installing the new tube. The yoke and focus coil are usually mounted in brackets which permit the units to be shifted slightly in all directions. Moving the deflection yoke toward the rear or shifting the focus coil to one side or rotating it about either axis will produce the trouble that you have.

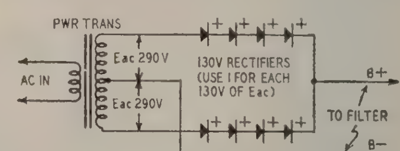
Check the deflection yoke and make sure that it fits snugly against the flare of the tube. Rotate it so the edges of the raster are square with the mask. Loosen the focus-coil adjusting screws and move the coil slightly toward the base of the tube setting it in the position which gives uniform focus over the greatest picture area. Move the coil up and down, from side to side, and swing it about both axes to obtain proper centering without neck shadow. Do not try to adjust the focus coil for maximum brightness at the expense of focus and centering.

Caution! Adjustments made to the focus coil and deflection yoke should be made carefully so that the position of the ion trap is not disturbed. Improper adjustment of the trap will result in ion-spot burn on the tube face.

USING SELENIUM RECTIFIERS

? *Can selenium rectifiers be used to replace the 5Y3-G and 5U4-G rectifiers in a G-E model 835 TV receiver? If so, please give type numbers of rectifiers that you recommend.—J. R. K., Cleveland, Ohio*

A. Typical radio-type selenium rectifiers are rated at 130 volts r.m.s. for each half-wave unit. The voltage between each of the 5U4-G plates in your set is approximately 335, so three rectifier units must be connected in series to replace each plate of the tube. Each of the rectifier stacks or units should



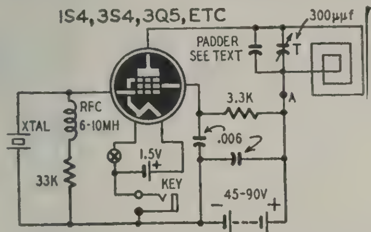
be rated at least 150 ma. Units rated at 200 ma are preferable. You will need six rectifiers to replace the 5U4-G in the full-wave rectifier circuit.

The 5Y3-G operates with 290 volts on each plate and the current drain is approximately 90 ma. Six 150-ma rectifiers are recommended for replacement. The circuit shows how selenium rectifiers can be used to replace a vacuum-tube rectifier in a full-wave circuit.

CONTROL TRANSMITTER

? *I am making a remote-controlled signaling system and would like to have a diagram of a small battery-powered transmitter operating between 400 and 500 kc. Its power must be sufficient for a range of about 50 feet. I want to use a loop antenna.—F. B., Lyons, N. J.*

A. The circuit of the transmitter is shown. It is crystal controlled. The loop antenna and tuning capacitor are selected to tune to the same frequency as



the crystal. The loop antenna may be one designed for a standard broadcast portable set. The circuit can be tuned to resonance by inserting a 10-ma meter at point A and varying the tuning capacitor for minimum plate current. It may be necessary to connect a small mica capacitor of 100 μμf or so in parallel with the trimmer to reach resonance at some frequencies.

Crystals for most frequencies in the 400-kc range can be obtained from surplus outlets for less than $1.00 each. There are many crystals available for the SSB exciter, for instance, which range in frequency from 400 to 500 kc, at 1-kc intervals.

GARAGE-DOOR OPENER QUERY

? *The radio-controlled garage-door opener described on page 62 of the March issue is not sensitive enough for my needs. At the present time, the maximum range is about four feet. Can I increase the sensitivity of the system?—J. L. D., Struthers, Ohio.*

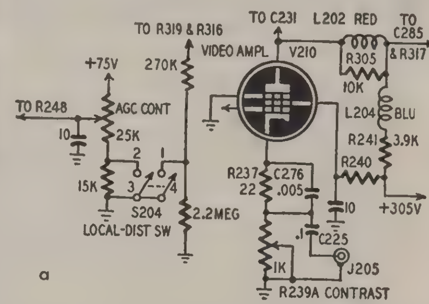
A. Try various adjustments of the spacing between the points on the ignition coil and on the spark gap. Replace the 1,000-ohm fixed cathode resistor with a wire-wound potentiometer of the same value. Decrease the resistance to the point where a further decrease will close the relay.

—end—

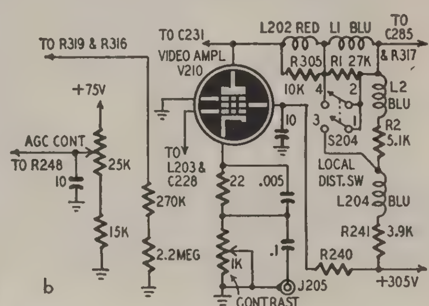
Suggested by M. B. Dunaway, Omaha, Neb.

DU MONT RA-112A, -113, -117

In some weak-signal areas it is impossible to obtain a satisfactory picture, even with a very good antenna system. By narrowing the bandwidth and increasing the gain of the video amplifier in these models, it is often possible to obtain a satisfactory picture where one

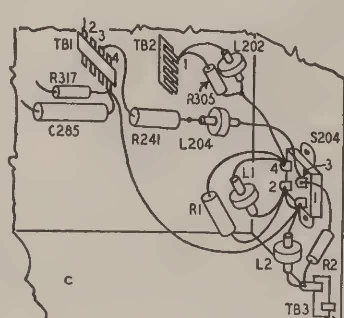


could not be obtained previously. The original circuit is shown at *a*, the modified circuit at *b*, and the location of components after modification at *c*. The LOCAL-DISTANCE switch is rewired so as to obtain normal bandwidth and



resolution on strong signals. Make the following changes:

1. Remove the black lead which runs from ground to terminals 3 and 4 of the LOCAL-DISTANCE switch S204.
2. Remove the orange lead between terminal 2 of S204 and the a.g.c. control.



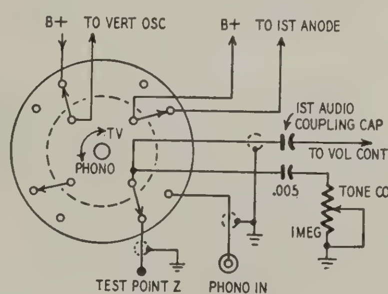
3. Disconnect L202, R305, and L204 from the junction of R317 and C285.
4. Connect the free ends of L202 and R305 together and connect to terminal 4 of S204.
5. Connect R1 (27,000 ohms, ½ watt, 10%) and L1 (peaking coil, part No. 21 006 627) in parallel between terminals 2 and 4 of S204.
6. Disconnect the junction of L204 and R241 from the terminal strip.
7. Connect L204 between the free end of R241 and terminal 3 of S204.
8. Mount a single-terminal tie-point in the corner of the chassis nearest S204.

9. Connect switch terminals 1 and 2 together and to the junction of C285 and R317.
10. Connect R2 (5,100 ohms, 2 watts, 5%) and peaking coil L2 (part No. 21 006 627) to the tie-point added in step 8.
11. Connect the free ends of R2 and L2 to terminals 3 and 1 respectively of S204.
12. Dress all components and leads for minimum capacitance.

The LOCAL-DISTANCE switch should be placed in the LOCAL position when receiving strong stations.—*Du Mont Service News*

ADDING PHONO TO ADMIRAL TV

It is simple to add a phonograph attachment to Admiral straight TV receivers. A 3-pole double-throw switch must be installed. One section transfers the input of the a.f. amplifier from the low-impedance ratio detector to the high-impedance phonograph pickup. The second section disables the vertical oscillator to prevent its radiations from entering the audio circuits when the first a.f. amplifier operates with a high-impedance input. The third section of the change-over switch breaks the B-plus lead to the first anode and prevents a bright horizontal line from appearing on the screen of the picture tube and possibly burning it.



A tone control can be conveniently added to the circuit while the phono connections are being added. A control which operates with the switch in the PHONO or TV position may consist of a .005-μf capacitor and 1-megohm variable resistor in series between ground and the hot lead to the volume control. Choose a tone control with "tone" taper.

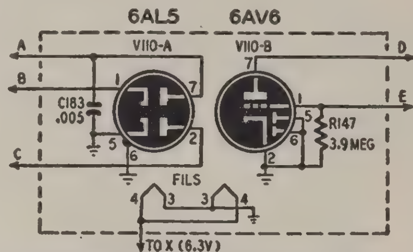
The diagram shows how the switch and tone control are connected. A Mallory 3242J or equivalent switch is used for change-over between TV and phonograph. The fourth section of this switch can be used to apply power to the phono motor. The switch and tone control should be mounted in a small plastic or metal box which can be placed on the rear of the receiver in an accessible position.—*Admiral Radio & TV Service Bulletin*

PHILCO 925, CODE 123

If it is impossible to track the FM oscillator in this model and the 926, inspect the r.f. choke in the plate circuit of the 12AT7 oscillator. This trouble occurs when two or more of the turns are shorted together. Separate the turns and hold in place with a few drops of coil dope.—*Milton Margolis*

CROSLEY 11-446 MU, 11-476 BU

Several production changes have been made on chassis 325 used in these models. On chassis 325-1, the 6T8 sound detector and audio amplifier tube is mounted on a plate-and-socket assembly (part No. AB-150226). A .005-µf, 500-volt disc-type ceramic capacitor is connected between ground and pin 2.



A-TO JUNCTION OF C132 & R143; B-TO LUG C OF T101; C-TO LUG D OF T101; D-TO JUNCTION OF C138, C137 & R148; E-TO JUNCTION OF C136 & R147

On chassis 325-2, a 6AL5 and 6AV6 are mounted on a socket-and-plate (part No. AB-150227) which replaces the 6T8 in earlier models. (See diagram) —*Crosley Television Service Bulletin*

A.G.C. ON CROSLEY TV SETS

Some receivers have an external a.g.c. adjustment on the rear of the chassis. This control determines the voltage level at which the second detector operates. The factory sets this adjustment for a strong signal, so it should be re-adjusted—at the time of installation—for the stations in the area.

Tune in the weakest station in the area and turn the adjustment clockwise or counterclockwise to the point at which the set overloads with the contrast control set at maximum. When the control is set too far counterclockwise, it results in poor sensitivity and a weak picture. When the adjustment is carried too far in the opposite direction, the detector overloads and the picture may be unstable on medium to strong signals.

If the set overloads on a strong signal after the a.g.c. control has been properly set, turn the contrast control toward minimum until the overload is eliminated. If the overload cannot be eliminated with the contrast control, it may be necessary to make a compromise a.g.c. adjustment for the weakest and strongest stations.—*Crosley Instruction Sheet*

HUM IN COMMUNICATIONS SETS

When you find a communications receiver with a bad case of hum which is not caused by any of the more well-known sources, take a look at the noise limiter. In most of these circuits the cathode of the noise-limiter diode is connected to a high-impedance point in the audio circuit. The slightest leakage between heater and cathode will cause a lot of hum in the audio system. The tube should be replaced with one having negligible heater-to-cathode leakage. Check the tube in the set to be sure.

In many sets this potential trouble spot can be eliminated by replacing the vacuum tube with a 1N34 or similar crystal diode.—*Charles Erwin Cohn*

—end—

TECHNICIAN LICENSES IN NEW YORK CITY PROPOSED

New York City's proposed licensing law for television technicians is expected to pass in revised form without opposition and will probably go into effect in October or November. Though the service technicians are not entirely convinced that licensing is the way out of the industry's dilemma, they have co-operated in framing the bill, and will be represented on the supervisory committee which it will set up.

The new law provides for licenses or permits for three classes: service contractors, technicians, and apprentices. Technicians' permits will be granted those who show proof that they have been engaged for two years in servicing receiver apparatus or testing electronic equipment, or who have completed a course in an approved school and have had one year's experience. This permit must be exchanged for a license before the end of June, 1953. Licenses are obtained on the successful completion of an examination in radio and television repair theory and techniques. Apparently no technician permits will be issued after June, 1953.

Apprentice permits will be issued to anyone employed as a service apprentice by an accredited technician or licensed service contractor.

The proposed law is less specific on the qualifications of a service contractor, but two classes of licenses will be issued. Type A licenses will be granted contractors who "have met the requirements prescribed by the commissioner," and Type B licenses to those who have not applied or have not qualified, as the case may be, for the Type A license.

The commissioner will not be the czar provided for in earlier bills; he will be required to explain his actions to a board of supervisors. This board, of seven members, will consist of a member of the board of education, a member of the city's law department, a member of the I.R.E., a skilled service technician, a service contractor, a dealer, and a distributor.

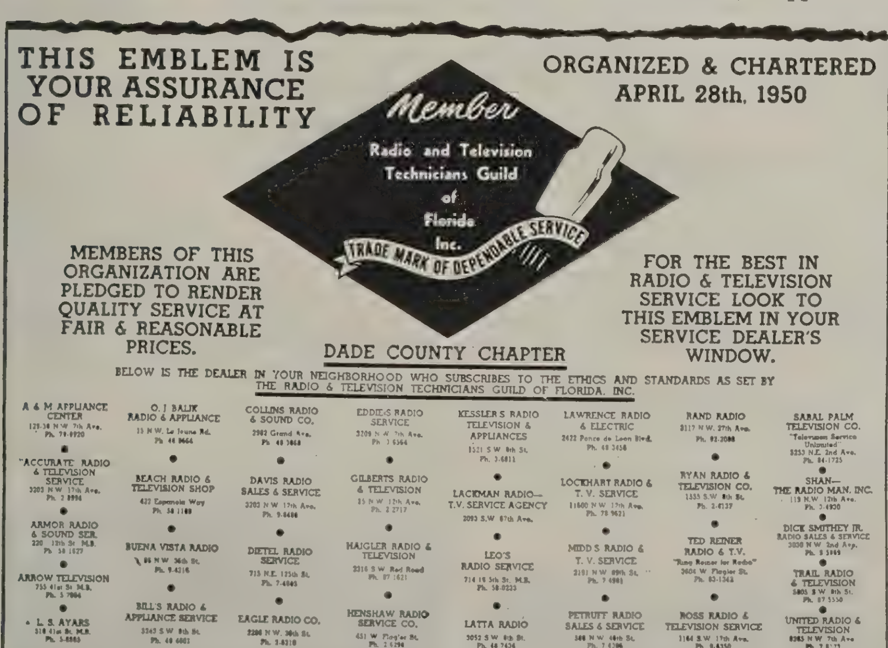
The committee shall recommend to the commissioner such rules and regulations as it deems necessary. While the commissioner is not bound to follow the recommendations of the committee, he must state his reasons in writing whenever he does not do so.

After 1953, all permits and licenses shall expire annually. Issuance or renewal of apprentice permit will cost $5, technician license $15, and service contractor license $25. Beginning July 1, 1953, it shall be illegal to act as a service contractor without a license, or to service radio or television receiving equipment for compensation without being in possession of a technician license or acting (as an apprentice) under the direct supervision of an accredited technician. Punishment for violations are stiff—maximums are a $1,000 fine and six months imprisonment, or both.

ACTIVE TECHNICIAN PUBLIC RELATIONS IN FLORIDA

Tom Middleton, former president of the Philadelphia Radio Service Men's Association (PRSMA), is now established in Miami, Florida, and has set up his own shop.

Tom reports an active organization of service technicians: The Radio and Television Technicians Guild of Florida. He sends a half-page co-operative ad in a Miami paper, which features the window emblem of the Guild, and assures prospective customers of the reliability of shops displaying that emblem. Under the head, "Below is the dealer in your neighborhood who subscribes to the ethics and standards set by the Radio & Television Technicians Guild of Florida, Inc.," appear the



Half-page ad in local Florida papers shows good sense in public relations.

names, shop addresses and phone numbers of 34 Guild members each set in one-column display type. The specimen sent was from the Miami Herald, but Tom reports that it appears "in the local papers," so presumably it is carried by others as well to achieve maximum effect.

LICENSES; MILWAUKEE AND L.A.

Licensing continues to be news on two fronts—Milwaukee and Los Angeles. In the City of Angels, councilmen, at last reports, were studying whether licensing would reduce the racketeering for which dishonest television technicians were recently given terms in jail. Meeting with them were representatives of the television and electric industry, the local service technicians association and the city's police and legal department.

After the discussion, the council committee moved that the industry group should come back within 30 days with concrete proposals embodying recommendations laid down at the meeting.

In Milwaukee, vigorous opposition to a proposed city ordinance which would regulate and license all television servicing was reported. Leading the fight were the local radio dealers' and appliance dealers' associations.

It should be noted the condition in Milwaukee is somewhat different from that in some other cities, states Howard Ashworth of the appliance association, since "there never has been, nor is there now, any so-called 'racket' television service association in Milwaukee."

According to a number of Milwaukee dealers, slow and unsatisfactory service has been the lot of many customers. This is believed due to a shortage of trained personnel and shortage of parts, and to the fact that much service time had to be expended on new receivers which came through defective from the distributor or manufacturer. These had to be put into working order before delivery to the customer.

Milwaukee technicians and dealers doubt whether an ordinance of the type proposed (said to be patterned on the New York City bill), would be of any value in Milwaukee.

N.J. CONTRACTORS ASSN. ELECTS

The Television Contractors Association of New Jersey elected as president Gus Friedman of Argus Television & Radio, Newark. Walter Ferry of East Orange was elected secretary, Lester Palmer, vice-president; and Ralph Terbush, treasurer.

The association discussed an advertising campaign to educate the public in regard to ethical television contracting. A committee was also set up to investigate and report on subcontract defense work.

87 DINE, TOUR, L.A. PLANT

Members of the Southern California Radio Technicians Association (RTA) were guests of Packard-Bell recently at

a dinner meeting and trip through the company's plant in Los Angeles.

The group of 87 who attended the dinner meeting represented the entire Southern California area, including many from Long Beach, San Pedro, Wilmington, Redlands, and Bellflower. RTA President Hal Myers, Vice-President Fred Abrams, Secretary Leo Huckins, and Treasurer Clarence Spencer were among those in attendance.

BOUQUETS TO TV TECHNICIANS

A group of people who believe the television technician has plenty of trouble and is nevertheless doing a good job has at last been found. The department store or furniture store type of television dealer is highly satisfied, in general, to sell television and leave servicing to service organizations.

The television technician will recognize and agree with the following reasons given by a number of St. Louis dealers interviewed by *Retailing Daily*.

"Our customers would expect too much. I never saw any type of merchandise which has as many potential headaches as TV. Every customer who has a little trouble with the adjustment of his picture . . . immediately assumes the set is no good," is the way one dealer sums up the situation. Another puts almost the same story in slightly different words: "Nuisance calls would be terrific . . . And it would be difficult to turn them down, particularly when they are people who have been doing business with you for years."

Department managers, trained in expense accounting, also realize it costs money to run a servicing business, and that organizing a service establishment causes headaches which do not necessarily originate with the customer. One of these points out: "We would have to set up a separate organization to handle TV service. This would mean about $10,000 to $15,000 inventory in parts, etc., and hiring a manager. In addition we would have to hire our own men. This is a tough job, and even full-fledged service organizations find it hard to get the right technical help."

Another says: "We would have to have fully as much additional space as my department now occupies. And, don't forget, service is a 24-hour proposition. People want service any time of the day or night."

Possibly some association should present a plaque to the furniture department store TV dealers of St. Louis for the most genuine and sincere appreciation they have received in a long time.

LIMITING WARRANTY TIME

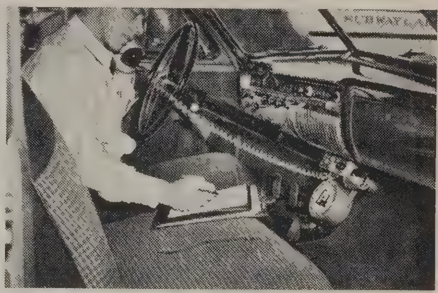
Limitation of warranties to the regular RTMA 90-day period was seen as a solution of one of the service dealers' problems by Frank Moch, president of the Television Installation Service Association (TISA) and the National Alliance of Television and Electronic Service Associations (NATESA), speaking before the RTMA Service

Committee meeting held in Chicago during June. Under the old plan, which the RMA spent many years to perfect, Mr. Moch stated, the customer would receive all the service to which he might be rightfully entitled. But statistics show that the average television set is used no less than 2,800 hours per year, so it is obvious that with a nominal life of 2,000 hours the 1-year plan gives the customer replacements on parts and tubes that have actually worn out. Warranties were never intended to do that.

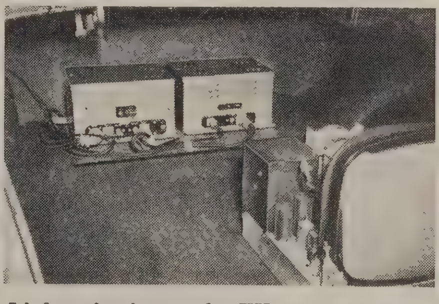
SPEEDING TV SERVICE

Tele-Vuers Service Center, Bloomfield, New Jersey, report they find radio very useful in running a radio and television service business. They have equipped a number of their service cars with Link two-way mobile radio, keeping the men in the field in close touch with the office and transmitting service calls as soon as received to a car in the vicinity.

Joseph G. Werner, Jr., one of the owners of Tele-Vuers, reports that the cost is repaid by the number of calls which were formerly lost due to the owner's habit of calling two or three service companies and giving the job to the first one to arrive. Very often in the past, he says, the service technician would arrive, to be greeted with, "Oh, some other service company has already repaired the set; they got here much sooner than you!" He says, "Since installing radio, we haven't lost a call!"



Service cars use two-way mobile radio.



Link units in trunk; TV set for repair.

The equipment also pays off in customer prestige, expressed by the considerable surprise often shown by customers at the speed with which calls are handled, and to the advertising value and publicity attendant on the installation. These gains are cinched, says Mr. Werner, by an ethical policy which rests on fair prices and not "pulling" a non-contract-covered set except when absolutely necessary.

—end—

THE SERVICE BOMBSHELL

Dear Editor:

We read with a great deal of interest your fair evaluation of the current Western Union Services debate as outlined in the editorial "Service Bombshell" in your July issue.

We thought you might be interested in our position as outlined in a letter we recently sent to a servicemen's association in Pennsylvania.

Best wishes for the continued success of your excellent magazine.

Cordially,

ALLEN B. DU MONT Laboratories, Inc.,
Teleset Service Control Dept.
Harold J. Schulman
Director of Service
East Paterson, N. J.

"We are indeed sorry to learn in your letter of May 31 that your organization has expressed its desire not to cooperate with the Du Mont technical meetings because of the entry of the Western Union organization into the service picture.

"We feel that a misunderstanding has arisen which, when cleared up will once again allow your members to continue their cordial relations with this company as in the past.

"As you may know by now, Du Mont did not authorize the Western Union Services, Inc., as a national service organization. The authorization was a limited affair involving three counties.

"No rates or privileges were given to Western Union that were not also given to any other authorized Du Mont service organization. They solicit service on an equal basis with other service companies; they obtain replacement parts through the local Du Mont distributor; their prices follow the recommended Du Mont price list.

"We hope you will agree that the greatest danger to legitimate service companies is the entry into the service field of poorly managed, inefficient, cutthroat service companies. We do not believe that honest competition by a company with the integrity and overhead of Western Union would be detrimental to the best interests and welfare of independent service dealers or organizations.

"At Du Mont we recognize very deeply the part played by service personnel in the maintenance of Du Mont Telesets and the continued enjoyment of television by our customers. We go to great expense to put out the best service manuals, monthly service publications and bulletins to keep service personnel informed. We run a school at our factory at no charge to qualified technicians. We maintain one of the largest staffs of field representatives in the television industry. And, we have no intention whatsoever to antagonize our many friends in the service business on whose good-will we depend so much.

"We hope that after you review the situation as it really exists you will withdraw your protest so that we can continue our friendly relationship in the future as in the past."

—end—

THE FUND TOPS $8,000.

HELP-FREDDIE-WALK FUND

The Help-Freddie-Walk Fund seems to have slackened somewhat in the summer months and we would urge our readers to consider once more the unfortunate youngster of Hershel Thomason, Arkansas radio technician, whose son was born completely armless and legless.

While in past months readers of RADIO-ELECTRONICS were responsible for contributing by far the largest sum of money to the Freddie fund, we do not wish to slacken our efforts and our readers are urged once more to help the unfortunate boy to grow up as a radioman when and if appliances can be fitted on him so that he can take care of himself.

At the present time this is, of course, not possible because Freddie, who just turned three, has only a so-called "leg appliance" which has taught him to balance himself. But so far he has not walked and will not until he has mastered the difficult job of coordinating the trunk muscles so he can twist his body from side to side to help walk. These appliances are extremely expensive and it is hoped that our readers will continue to contribute to the Freddie fund as heretofore.

Freddie is three now, and smiling. Won't you help him to keep on smiling?

Please send your contributions from time to time—even the smallest donation will be greatly welcome.

Make all checks, money orders, etc., payable to Herschel Thomason. Please address all letters to:

Help-Freddie-Walk Fund
c/o RADIO-ELECTRONICS
25 West Broadway
New York 7, N. Y.

We are pleased to report the following:

$75.00 contributed on behalf of the management and the employees of Lessing Rudner Footwear, Inc., Norwalk, Conn., through E. Ash.

FAMILY CIRCLE CONTRIBUTIONS

Balance as of June 19, 1951	$417.45
Mrs. P. Britton—Lackawanna, N. Y.	2.00
Mrs. L. Mandino—Waterbury, Conn.	1.00
FAMILY CIRCLE Contributions received up to July 19, 1951	$420.45

RADIO-ELECTRONICS CONTRIBUTIONS

Balance as of June 19, 1951	$7,949.83
Anonymous—Glendale, Calif.	1.00
Anonymous—San Francisco, Calif. ..	1.00
Anonymous—Everett, Mass.	2.00
Anonymous—Middletown, N. Y.	1.00
Anonymous—Everett, Wash.	2.00
George N. Ashley—Chatham, N. Y.	2.00
Harry O. de Gourville—Port-au-France, Martinique, F.W.I.	.85
George Mackey—The Dalles, Oregon	5.00
Management and Employees of Lessing Rudner Footwear, Inc.—Norwalk, Conn.	75.00
John Noreiko—Dearborn, Mich.	1.00
Harold Reed—Hyattsville, Md.	1.00
Hugh Ridall—Wilkes-Barre, Pa.	5.00
Schroeders—San Antonio, Texas	.50
S/Sgt. William F. Sweet—Burtonwood, England	10.00
E. Szabo—Defiance, Ohio	2.00
Wilmar, Calif.	1.00
RADIO-ELECTRONICS contributions	8,060.18
FAMILY CIRCLE contributions	420.45
Total received to July 19, 1951	$8,480.63

Radio Thirty-Five Years Ago
In Gernsback Publications

HUGO GERNSBACK
Founder

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

SEPTEMBER, 1917
ELECTRICAL EXPERIMENTER

U. S. Blows Up Tesla Radio Tower

Secret Radio Aerials, by H. Gernsback

A Remarkable Amateur Radio Station with a Record, by A. F. Pendleton

A French Radio Controlled Torpedo, by Frank C. Perkins

The Present Status of the Audion, by Dr. Lee de Forest

"Radio"—Communication Over Gas and Water Pipes—"Wired Wireless"

A Victrola Tikker, by F. C. Hamilton

An Efficient Scheme for Learning the Code, by Joseph Braff

Seven Years of Wireless, by Howard S. Pyle

600-TUBE PRECISION FREQUENCY STANDARD

Master timekeeper, recently placed in operation at the Bell Telephone Laboratories (Murray Hill, N. J.), is expected to vary less than one ten-thousandths of a second per day; this corresponds to a precision of 1 second in 30 years.

The secret of this split-second precision lies in four extremely stable quartz crystals which vibrate at 100,000 cycles per second. Crystal units can be seen at left and right of photo.

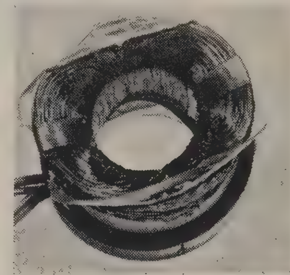
The entire apparatus uses about 600 tubes and has over 25,000 soldered connections. The equipment is housed in air-conditioned rooms and the crystals are enclosed in containers from which all the air has been pumped. The temperature of the crystals is controlled to within a hundredth of a degree.

600-tube frequency standard will vary less than one second in next thirty years.

COSINE YOKE

Merit Transformer Corporation, 4427 North Clark St., Chicago, is manufacturing two cosine yokes, MDF-70 and MDF-30.

The MDF-70 is a cosine yoke with distributed winding for edge-to-edge picture focus. A high-efficiency ferrite core permits use with all picture tubes

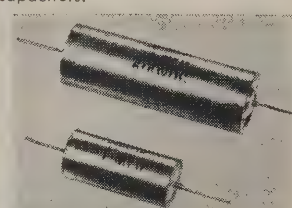


up to and including 24 inch where they require 70° deflection. It is recommended for use with HVO-6 and HVO-7 ferrite-core flybacks.

The MDF-30 is of the same design as MDF-70 but has high horizontal and low vertical inductance for use with HVO-8 air-core flyback in direct-drive systems. All Merit yokes are now equipped with resistance-capacitance network and leads.

SMALL CAPACITORS

Cornell-Dubilier Electric Corporation, South Plainfield, N. J., is introducing a complete metallized paper tubular line, available is three basic types—the Pup, Sealpup, and Metapup. They are extremely small, representing a 50 to 75% size reduction over foil or conventional types of paper dielectric capacitors.

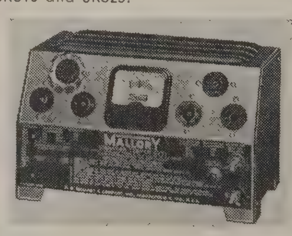


The Pup is a metallized unit available in nine capacitances from .01 to 2.0 µf. Smallest dimensions are $\frac{3}{8}$ x $\frac{5}{8}$ inch. The Sealpup is a smaller, highly dependable type, with a positive seal against moisture, and ranges in size from 0.175 x 11/16 inch up. It comes in 11 capacitance ranges from .01 to 2.0 µf in value.

The Metapup is enclosed in a one-piece metal tubular case, pressure sealed, and available in 12 capacitances from .01 to 6.0 µf. All three types are available at working voltages up to 600.

VIBRATOR TESTER

P. R. Mallory & Co., Inc., Indianapolis, Ind., announces a vibrator tester as an addition to its line of electronic products. This tester gives direct "good-bad" readings on doubtful vibrators. It is a companion unit to the Mallory 6RS10 and 6RS25.



With this tester, a direct test without adapters may be made of most vibrators used in passenger car radios manufactured since 1940. By plugging the rectifier tube into the front panel, interrupter type vibrators can be tested in conjunction with the same rectifier tube used in the car radio.

This tester may be used with the Mallory filtered rectifier power supplies, or will operate from any 6-volt d.c. source which can be adjusted between 4 and 6 volts.

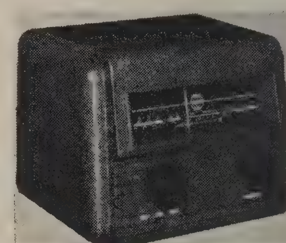
SPEAKER CABINET

Jensen Manufacturing Co., 6601 South Laramie, Chicago, Ill., is producing a cabinet which simplifies speaker installation and removal.

Known as the Jensen Customode Imperial, the new cabinet has four decorative brass knobs at the corners of the front panel. By removing these knobs, the entire panel, with the speaker, may be removed.

TV BOOSTER

The Turner Company, Cedar Rapids, Iowa, is producing a new television

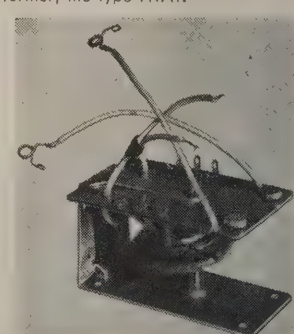


booster, model TV-1, using a greatly improved circuit which covers television channels 2 to 13 with continuous tuning.

The new booster employs the cascode circuit, noted for its low noise factor. It is supplied complete with ribbon lines for quick connection to a receiver. A terminal strip accommodates either 75-ohm coaxial or 300-ohm flat transmission lines.

FLYBACK UNIT

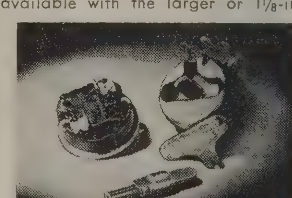
Allan B. Du Mont Laboratories, East Paterson, N.J., has made available to the trade a new horizontal deflection output and high-voltage transformer, the type HIA1.



It features a high-efficiency design with a ferrite core and special windings, and is capable of supplying 12 to 13 kilovolts to a 70-degree tube. Mounting is so designed that the unit lends itself to either horizontal or vertical mounting without special hardware.

SMALL AD-A-SWITCH

Clarostat Manufacturing Co., Dover, N. H., announces that the flexibility of choosing the desired combination of control, switch, and shaft, heretofore available with the larger or $1\frac{1}{8}$-inch



All specifications given are obtained from manufacturer's data.

diameter volume control replacements, is now extended to the smaller 15/16-inch diameter size as well.

The series SWB or 15/16-inch AD-A-Switch is obtainable in s.p.s.t 3-way no OFF position, s.p.d.t., and d.p.s.t. A T-shaped section of the control's dust cap is simply pried off, turned 90 degrees and taken off, exposing the switch-throwing mechanism. The switch readily slips in place.

WATT-VOLTMETER

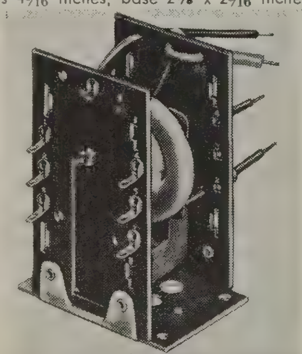
Triplett Electrical Instrument Co., Bluffton, Ohio, has added the model 660 Load-Chek watt-voltmeter to their line of test equipment.

The wattmeter is designed to aid the service technician in discovering shorts and overloads. By plugging in a set and comparing the wattage used with the nominal wattage of the set, shorts or overloads can be detected immediately. Wattage ranges are 0-500-1,000 a.c. and d.c. The voltage range is 0-130 a.c. or d.c.

H.V. OUTPUT UNIT

The Standard Transformer Corporation, 3580 Elston Ave., Chicago 18, Illinois, has added a TV replacement unit, the A-8130 horizontal deflection output transformer, to its line.

The unit is for use in pulse-operated, single-rectifier power supplies to deliver up to 14,000 volts with adequate sweep for full horizontal scan of 65-70° kinescopes having up to 24-inch screens. For conversion of older TV receivers to take newer picture tube types, it was announced, it requires a 3-27 mh width-control coil. Over-all height of the unit is 4 1/16 inches, base 2 7/8 x 2 3/16 inches.

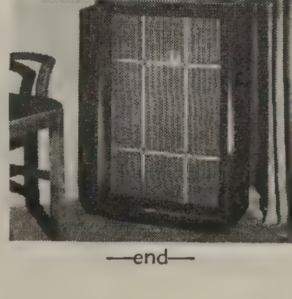


CORNER SPEAKER

Electro-Voice, Inc., Buchanan, Michigan, announces a small-size, low-cost, folded-corner horn enclosure with direct front radiation for 12-inch full-range speakers.

The new E-V Aristocrat unit utilizes the Klipsch principle, using the corner of a room as an extension of the exponential acoustic-horn air load. Extended bass reproduction is achieved down to 35 cycles.

The Aristocrat enclosure has been designed to produce optimum results with Electro-Voice Radax full-range 12-inch speakers. Compliance and cone resonance of these units match the characteristics of the cabinet. It improves the operation of any 12-inch speaker.



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ELEMENT VIII, SHIP RADAR TECHNIQUES, supplement to Radio Operator's License Q&A Manual—2nd edition, by Milton Kaufman. Published by John F. Rider Publisher, Inc., 480 Canal St., New York 13, N.Y. 5⅜ x 8¼ inches, 32 pages. Price 78 cents.

The FCC requires (since Jan. 2, 1951), that to do radar work on ships an "operator must have a first- or second-class radiotelephone or radiotelegraph license plus a ship radar endorsement" (Element VIII is required). This small supplement provides clear answers to the questions of the element, including 17 illustrations. An incomplete index is appended.—*MMK*

ELECTRONIC MECHANISMS OF ORGANIC REACTIONS, by Allan R. Day. Published by the American Book Co., 88 Lexington Ave., New York 16, N.Y. 6 x 9 inches, 314 pages, Price $3.50.

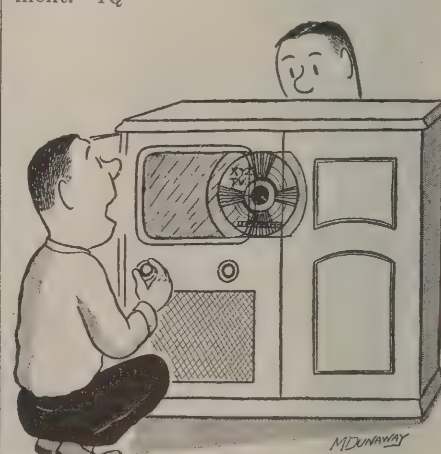
This book describes the reactions of aliphatic and aromatic compounds on the basis of electrochemical theory. Formation of valence bonds, causes of tautomerization, and isomerization reactions are discussed in addition to a systematic exploration of the hydrocarbons.—*MMK*

LINES, NETWORKS and FILTERS by William M. Breazeale and Lawrence R. Quarles. Published by International Textbook Co., Scranton, Pa., 6 x 9, inches, 293 pages. Price $6.50.

This volume deals entirely with communication by wire. It is intended for students or technicians who have the equivalent of two years of college math and who know a.c. theory. Algebra is used throughout to show fundamental properties of transmission lines and lumped networks at low and high frequencies.

Each chapter provides numerical examples which illustrate the use of the equations and show how to design lines and circuits. Rationalized MKS units are employed. Vector diagrams and graphs supplement the mathematics. The important impedance and Smith charts are explained.

Tables of hyperbolic, Bessel and other functions appear at the end of the book. There is also a short list of suggested experiments in line measurement.—*IQ*



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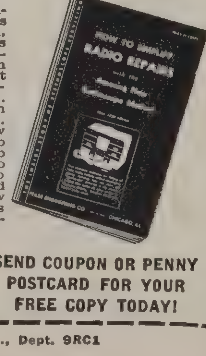

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MOST-OFTEN-NEEDED 1951 RADIO DIAGRAMS and Complete Index, compiled by M. N. Beitman. Published by Supreme Publications, Chicago, Ill. Volume 11, 8½ x 10¾ inches, 192 pages. Price $2.50.

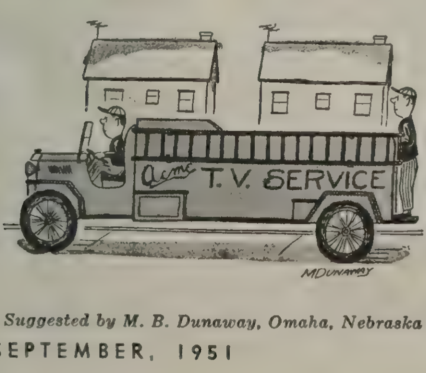
Volume 11 is the latest addition to the Most-Often-Needed series. It contains schematic diagrams, alignment charts, socket voltages, dial stringing information, and other pertinent servicing data on approximately 500 different units. These include portables, a.c.-d.c., AM-FM, and automobile sets, combinations, and record changers made by 37 manufacturers. A 3-page volume index appears in the front of the book. A 22-page master index in the rear lists the material covered in volumes 1 through 10 (1928 through 1950) and in volumes TV1 through TV5 (1947 through 1951).—*RFS*

RADIO HANDBOOK (Thirteenth Edition), edited by R. L. Dawley. Published by Editors and Engineers, Ltd., Santa Barbara, Cal. 7 x 9½ inches, 734 pages. Price $6.00.

The latest edition is a revised, up-to-date, twice-the-size version of the 12th edition published several years ago. The type is large and easy to read and the material is well illustrated with diagrams, pictorial drawings, design charts, and photographs.

The section on antennas is especially complete. There are 111 pages on this subject alone. Also of interest to hams are the sections on single-sideband generators, TVI elimination, mobile equipment and installations, precision v.f.o.'s, clamp-tube modulation systems, and specialized test and measuring equipment such as standing-wave indicators, and grid-dip meters. Sections devoted to transmitters and transmitter circuits are sufficiently complete to satisfy those interested in both high- and low-power units.

Although various types of receiver circuits and equipment are discussed, there is surprisingly little practical constructional material. The book would be more useful to amateurs, SWL's, and communications engineers if it included practical material on single-sideband and panoramic adapters, crystal-controlled markers for receivers, and a precision frequency meter useful in the v.h.f. range. It could also include details on modernizing and souping-up some of the older receivers and transmitters used in communication circles in the days before World War II. The coverage could be similar to that given surplus equipment in the 11th edition.—*RFS*



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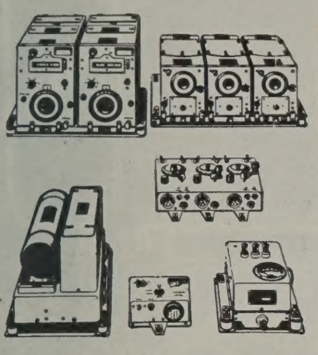

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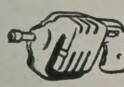

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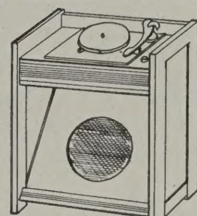

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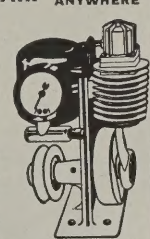
- Extra Special—We have a few of the Magnavox amplifiers alone, brand new and identical with the amplifier in the record demonstrator listed above. These have the separate bass and treble tone controls and volume control, and are complete with tubes. Believe it or not, we are letting these prizes go for a $20.00 bill each. A bargain like this would be unbelievable before Korea, let alone now.

WINDOW ANTENNA

Highest quality telescoping folded dipole antenna with all the features usually expected in such an antenna, including use as a dipole and reflector, and in addition a mounting bracket provided so that the antenna can be installed in any window in two minutes or less. Any slight loss in gain because of the reduction from roof-top height is more than compensated by ability to orient antenna instantly by opening window and adjusting for maximum signal strength. Mounting bar can be installed horizontally or vertically in window frame or even between attic rafters, whichever is most convenient. Your cost **$7.00.** With high frequency attachment for channels 7 to 13, **$9.00.** Either type 10% less in dozen lots.

P.M. Auto Speaker for rear seat installation including 3 way switch to turn on front or rear speaker or both. Try to match this bargain at twice the price. **$3.50** each, 2 for **$6.00,** 10 for **$27.00.** If desired, black crackle metal cabinets to fit above speakers can be purchased with speakers for **$1.50** each.

COMPRESSED AIR INSTANTLY ANYWHERE



Portable Air Compressor and storage tank. Ruggedly built of best materials using lifetime lubricated ball bearing on connecting rod and oil-impregnated main bearing on shaft. Unusual design forever eliminates valve trouble, the most common fault in air compressors.

PATENTED unique air intake system increases efficiency tremendously over other compressors so that air output is much greater than that from larger compressors powered by heavier motors. Will deliver approximately 3500 cu. inches of air per minute at maintained pressure of 30 lbs., or will inflate a 90 lb. truck tire in less than one minute. Comes complete with 100 lb. gauge, although finger-tip adjustment allows setting of output pressure at any value, which will automatically be maintained. Works from any 1/4 H.P. motor. Useful for spraying paints or lacquers, disinfectants, insecticides, annealing or brazing with natural gas, inflating tires, etc. Price **$14.50** postage prepaid anywhere in the U. S. Efficient, completely adjustable syphon type spray gun complete with 12 ft. of 100 lb. tested hose available prepaid. 25% required on all C.O.D. orders. for only **$7.75** with pint container, also **MAGNAVOX** 33⅓ R.P.M. portable record players with extremely heavy turntable to minimize wow and speaker feedback. Special Magnavox LP arm and crystal cartridge to reduce record wear to absolute minimum. Connects to any radio or audio amplifier. Heavy brass hardware on cabinet & cover. A deluxe job. **$16.00** each or 2 for **$30.00.**

MIDGET I WATT TRANSMITTER supplied complete with polystyrene coil forms for 3 ham bands. Size overall 3"x1"x2½" high. Includes practically all necessary parts. Your Cost **$1.50**

SIGNAL GENERATOR

Genuine Laboratory-type precision signal generator Manufactured and sold for $68.00 each in large quantities during the war by Northeastern Engineering Corp., one of the top manufacturers of electronic equipment for the U. S. Govt. Five fundamental bands starting at 150 KC. Strong harmonics up to 120 MC. Five step ladder type attenuator as well as potentiometer output control. Regular 1000 cycle audio oscillator using vacuum tube, not a cheap neon sawtooth audio oscillator. Audio output separately available externally. Weight without packing material 16 lbs. which should show what a world of difference exists between this signal generator and the ordinary cheap oscillator used by the average serviceman. Complete with fused plug and coaxial output lead. Super Special $28.75

1000 CYCLE AUDIO FILTER

With TOROID Coils

Navy PD52010-1 low pass audio filters as mentioned in the "Peaked Audio" article in June CQ, and designated by the above number, are the exact electrical and physical equivalents of commercial audio filter units selling for $35.00 wholesale. They are infinitely better than surplus "Radio Range Filters" being sold for reducing QRM, and at 2 KC off resonance, for example, a 2 section filter using PD52010-1 is capable of twice the selectivity available through use of the Q5-er (the BC453 section of the 274N which has provided the amateur's previous highest standard of interference elimination). **EXTRA SPECIAL NAVY PD52010-1** with diagram......**$2.00**

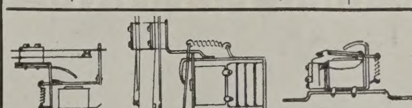
HOME WORKSHOP AT BARGAIN PRICE. Accurate and precise 2 speed guaranteed hobby lathe, the essential machine for the home workshop. Sturdy enough for light production work or factory standby service. Supplied with 56' of belting for connecting to any available electric motor or power take-off. Also included in this unbelievable offer are such accessories as ½" drill chuck with specially hardened tool steel jaws, a 4" electric furnace high speed grinding wheel, a cotton buffing wheel and a large supply of buffing compound, and a 4" steel wire scratch brush. Your cost **$6.00.** Sole export agent. Distributor inquiries invited.

WORLD'S LARGEST STOCK

Coaxial and "AN." Connectors. Write for prices on types desired. IMMEDIATE DELIVERY

A. C. RELAYS

Coil	Specification	Contact Amperes	Net.
6-8V	S.P.S.T. N.O.	3	$1.50
12-15V	S.P.S.T. N.O.	3	1.25
25-30V	3P.S.T. N.O.	3	2.00
25-30V	S.P.S.T. Normally Closed S.P.S.T. Normally Open	3	2.00
55V	D.P.D.T.	10	2.50
110V	3P.S.T. Normally Open S.P.S.T. Normally Closed	3	2.00
110V	D.P.D.T.	15	3.00



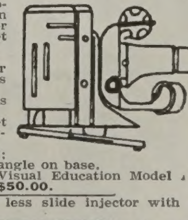
D. C. RELAYS

Coil	Specifications	Contact Amperes	Net.
800 ohms 10m.a.	D.P.D.T.	3	$2.00
2000 ohms 4.5m.a.	S.P.D.T. Hermetic	3	2.75
2000 ohms 1 m.a.	S.P.D.T. Hermetic	3	3.75
12 Volts	D.P.D.T. Midget	3	.60
45 Volts	D.P.D.T.&S.P.S.T.N.O.	3	1.70

35MM SLIDE PROJECTOR & ENLARGER

Most terrific photographic bargain of the 20th century. A fine precision instrument with many features!!

- Takes roll film or 2x2 slides.
- Automatic slide changer furnished.
- No more wainting for enlargements to enjoy your candid shots. All you need is a flat surface to project on.
- Has 300 W 110 VBulb, but 6V, 12V, 32V, or 220V available.
- 8 precision ground, optical glass elements in optical system.(No other projector on the market has more.)
- Heat absorbing filter.
- Use as an enlarger for making your own prints of any desired size.
- Piano-Convex Meniscus Condenser.
- 5" focus Brown-Violet coated, double anastigmat F:3.5 lens.
- Swivel projector head;
- Projector tilts to any angle on base.



Brand New Society for Visual Education Model AA Projector. Super Special **$50.00.**

Similar S.V.E. Projector less slide injector with uncoated lens **$37.50**

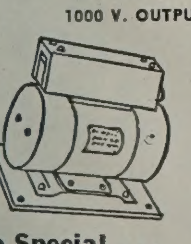
35 mm 150 W Projector similar to above, less sl de injector with uncoated lens **$17.50**

STOP IT'S MOBILE RADIO TIME AT BUFRAD

6 Volt Dynamotor

Made for use with G.E. Equipment. Worth over $250.00. So husky we can give a standard R.M.A. Guarantee on this item. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

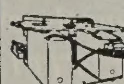
1000 V. OUTPUT AT 350 MA.



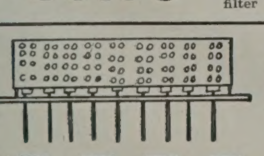
- By running with end bells removed will supply 500 MA. safely
- Constant output voltage under varying load because of compound winding
- Low input current (18 to 100 amps. depending on transmitter drain)
- Regular car battery will supply enough power for push-to-talk operation
- Starting solenoid for remote operation from mike switch
- Both sides of output voltage insulated from ground
- Brand new in original factory boxes
- Both input and output fused
- Built-in interference filter

• Special . . .

$39.95



3-Gang Broadcast Band Permeability tuner. Was $3.50. Now $1.50

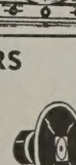


PUSH SWITCH 9 Section. Make-Break & SPDT ea. Pressing one releases all others.

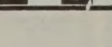
98c

COAXIAL SPEAKERS

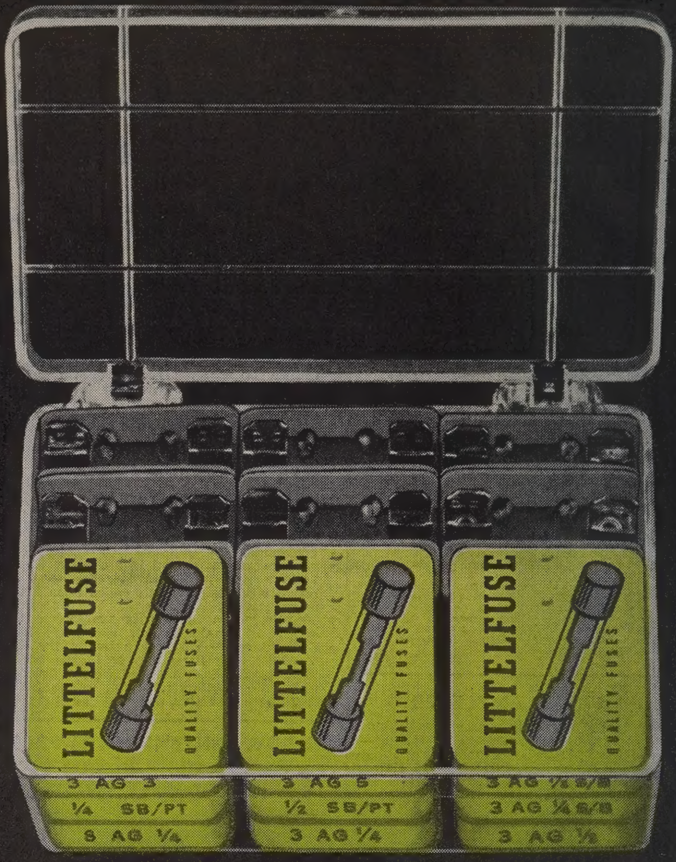
Latest model coaxial speakers. Woofertweeter design. Response 40-17,500 cps. New efficient speakers represent the result of years of research. Low and high pass filter built in. Only 2 wires to connect. 8 ohms impedance. Only **$13.50** each or 2 for **$26.00.**



Super Midget Mike Xfmr.



Occupies less than 1/4" of space. This is the tiny, high quality transformer that is used inside bullet dynamic or velocity mikes to match the input of an amplifier tube. Makes a terrific Intercom set input xfmr to couple from the voice coil of a speaker to the amplifier input. Better quality and marked reduction in hum compared to other transformers. A beautiful input xfmr for a transceiver because of high quality & light weight. Special **$1.00** Postpaid



Servicemen can cover 94% of fuse replacements with this kit

One-Call Kit Contains 45 TV fuses (6 most in demand types) and 6 TV snap on fuse holders in a clear plastic hinged-cover bench box. Another LITTELFUSE first. Call your jobber today. Littelfuse, Inc., 4757 Ravenswood, Chicago 40. LOngbeach 1-4970.

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